
ADDITIONAL UINTAN AND DUCHESNEAN (MIDDLE AND LATE EOCENE) MAMMALS FROM THE SESPE FORMATION, SIMI VALLEY, CALIFORNIA

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ABSTRACT. A paleontologic resource impact mitigation program at the Simi Valley Landfill, Ventura County, California, is yielding new taxa and new geologic records of middle and late Eocene mammals from the middle member of the Sespe Formation. New Uintan taxa and new occurrences recorded from Simi Valley are *Centetodon* sp., cf. *C. aztecus*; erinaceomorph, gen. and sp. undet.; *Uintasorex* sp., cf. *U. montezumicus*; *Microparamys woodi* n. sp.; *Microparamys* sp., cf. *M. tricus*; *Miacis* sp. undet.; and ?isctolophid, gen. and sp. undet. New Duchesnean taxa and new occurrences recorded from Simi Valley are *Peradectes californicus*; *Leptotomus* sp. undet.; ?Camelidae, gen. and sp. undet.; *Simimeryx* sp., aff. *S. hudsoni*; and Mammalia, gen. and sp. undet. *Sespedectes singularis* is now recorded from the Simi Valley Landfill Local Fauna, and this occurrence extends the geologic range of this species upward into the late Duchesnean. Additional specimens of the rare taxa *Dyseolemur pacificus*, *Griphomys alecer*, and *Protylopus robustus* are now available and allow reevaluation of the intraspecific variation in the teeth of these species.

INTRODUCTION

The middle member of the nonmarine Sespe Formation, which is exposed along the northern side of Simi Valley, Ventura County, California, has yielded diverse middle and late Eocene land mammal assemblages (Stock, 1932; Golz, 1976; Golz and Lillegraven, 1977; Mason, 1988; Kelly, 1990, 1992; Kelly et al., 1991). Kelly et al. (1991) documented the preliminary results of a paleontologic resource impact mitigation program that is being conducted in the lower and middle members of the Sespe Formation at the Simi Valley Landfill. The program has yielded many new taxa and new geologic and geographic records from the Sespe Formation that were discussed only briefly by Kelly et al. (1991). Many of these new taxa and records are biostratigraphically significant and have not been adequately described. Kelly (1992) recently described the rodents of the families Eomyidae, Heliscomyidae, Simimyidae, and ?Zapodidae recovered during the program. The report herein describes additional new taxa and new specimens of poorly known taxa that were discovered during the program.

METHODS

All specimens were recovered from the middle member of the Sespe Formation by a process described by Kelly et al. (1991) that included wet screening of bulk matrix samples and heavy liquid separation of fossils. All specimens described herein are deposited in the Vertebrate Paleontology Collection of the Natural History Museum of Los Angeles County.

Measurements of large teeth were made to the nearest 0.1 mm with a vernier caliper, and those of smaller teeth were made with an AO optical micrometer to the nearest 0.01 mm. All teeth were measured at their greatest dimensions. Metric abbreviations and dental formulae follow standard usage.

All cladistic analyses were performed using Version 1.5 of the Hennig86 computer program (Farris, 1988) and run on a 386 personal computer. Cladograms were generated using the IE COMMAND that computes the most parsimonious cladograms by implicit enumeration. Weighting of characters was accomplished by using the XSTEPS W COMMAND that sets the character weights of the cladograms generated by the IE COMMAND by calculating the best fits of each character based on the product of the character consistency and character retention indices. The characters and character states used in the cladistic analyses are presented in Appendix A and the character state matrices for each group of taxa analyzed are presented in Appendices B, C, and D.

Institutional acronyms are as follows:

CIT—California Institute of Technology

LACM—Natural History Museum of Los Angeles County

1. Vertebrate Paleontology Section, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California 90007.

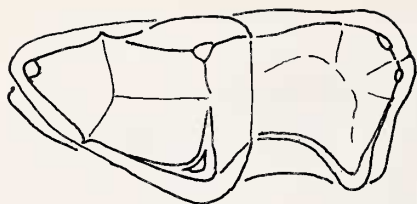


Figure 1. *Peradectes californicus* (Stock), LM₁, LACM 132422, occlusal view. Scale = 0.5 mm.

LACM (CIT)—California Institute of Technology locality, numbers and specimens now held by LACM
 UCMP—University of California, Berkeley, Museum of Paleontology
 UCMP-V—University of California, Berkeley, Museum of Paleontology, vertebrate fossil locality
 UCR—University of California, Riverside, Department of Earth Sciences

Abbreviations are as follows:

- A-P—Anteroposterior
- ANT—anterior
- Ar-Ar—argon-argon
- C.V.—coefficient of variation
- K-Ar—Potassium-argon
- L—left
- Ma—million years before present
- N—number of specimens
- O.R.—observed range
- POST—posterior
- R—right
- S.D.—standard deviation
- TR—transverse

SYSTEMATIC PALEONTOLOGY

Order Marsupialia Illiger, 1811

Family Didelphidae Gray, 1821

Tribe Peradectini Crochet, 1979

Genus *Peradectes*
 Matthew and Granger, 1921

Peradectes californicus
 (Stock, 1936)

Figure 1

REFERRED SPECIMEN. LM₁, LACM 132422.
LOCALITY. LACM 5876.

FAUNA AND AGE. Simi Valley Landfill Local Fauna, late Duchesnean.

DISCUSSION. The M₁ of LACM 132422 exhibits the diagnostic characters of *Peradectes californicus*, including a paraconid that is larger than the metaconid, a reduced entoconid, a weak entoconid notch, a dorsally projecting hypoconulid that is twinned with the entoconid, and a cristid obliqua that extends posteriorly from the trigonid before turning labially. The measurements of LACM 132422 are 1.55 mm A-P, 0.71 mm ANT-TR, and 0.75 mm POST-TR.

Peradectes californicus was previously known

from the late Uintan Tapo Canyon and Brea Canyon Local Faunas of the Sespe Formation (Stock, 1936; Golz, 1976; Kelly, 1990; Kelly et al., 1991), the late Uintan Mission Valley and upper ?Santiago Formations from the San Diego and Oceanside areas of California (Lillegraven, 1976; Walsh, 1991), the latest Uintan or earliest Duchesnean Camp San Onofre Local Fauna from the ?Santiago Formation on the Camp Pendleton Marine Corps Base in California (Lillegraven, 1976), and the late Uintan to early Duchesnean Badwater Localities 5, 5 Front, 5 Back, 6, and 20 of the ?Wagon Bed Formation in Wyoming (Krishtalka and Stucky, 1983). The recovery of *P. californicus* from locality LACM 5876 represents the first Duchesnean record of this species from the Sespe Formation and extends the geologic range of the species into the late Duchesnean.

Order Insectivora Illiger, 1811

Family Geolabididae
 McKenna, 1960

Genus *Centetodon* Marsh, 1872

Centetodon sp., cf. *C. aztecus*
 Lillegraven, McKenna,
 and Krishtalka, 1981

Figure 2, Table 1

REFERRED SPECIMENS. RM¹, LACM 130750; 2LM₁s, LACM 130831, 130832 4LM₂s, LACM 130830, 130835, 130837, 130838; RM₂, LACM 130839; RM₃, LACM 130829.

LOCALITIES. LACM 5661, 5857, 5866, 5869.

FAUNAS AND AGE. Tapo Canyon and Brea Canyon Local Faunas, late Uintan.

DESCRIPTION. Only one upper molar referable to *Centetodon* has been recovered during the impact mitigation program. The upper molar has a robust parastyle that is directed anterolabially. The large metastyle is directed posterolabially and positioned much farther labially than the parastyle. The paracone and metacone are conical cusps with sharp-tipped apices and are positioned relatively close together towards the midline of the tooth. The protocone is a well-developed cusp with the preprotocrista and postprotocrista extending to a very small protoconule and metaconule, respectively. The anterior cingulum is moderately developed and extends lingually from the middle of the anterior surface of the tooth to the anterolingual base of the protocone. The posterior cingulum is well developed and extends lingually from the posterior surface of the tooth, at the level of the metaconule, to terminate in a distinct small bulge at the posterolingual base of the protocone. Although the roots are broken off near the base of the tooth, a single lingual root appears to have been present.

The lower molars are typical of those of *Centetodon* and are characterized by the following: (1) they have a basic tribosphenic pattern; (2) the an-

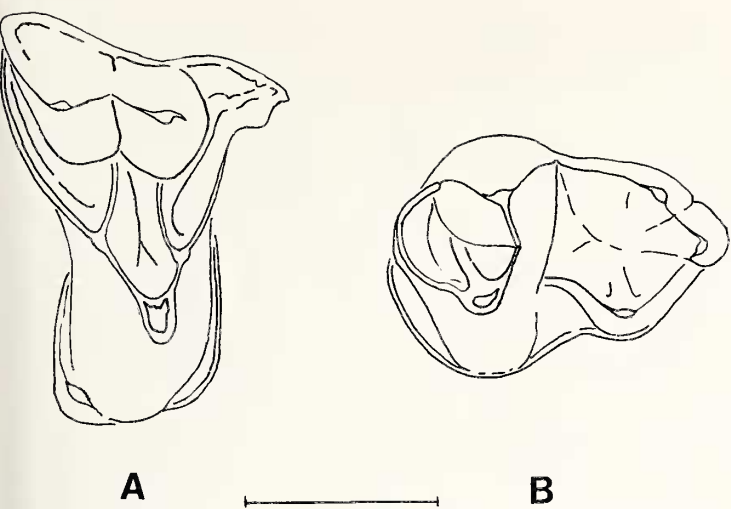


Figure 2. *Centetodon* sp., cf. *C. aztecus* Lillegraven et al., A. RM¹, LACM 130750; B. LM², LACM 130835. All occlusal views. Scale = 1 mm.

terior cingulid is well developed; (3) the paraconid is shelf-like; (4) the protoconid is the tallest cusp; (5) the cristid obliqua is usually medially concave; and (6) the entoconid and hypoconulid are positioned close together on the M₁₋₂.

DISCUSSION. The specimens of *Centetodon* from Simi Valley are very similar morphologically to those of *C. aztecus* of the Friars and Mission Valley Formations from the San Diego area, California, particularly with regard to the possession of a medially concave cristid obliqua on the lower molars. The mean measurements of the lower molars from Simi Valley are slightly larger than those of the sample of *C. aztecus* from the San Diego area. However, all of the Simi Valley lower molars fall within the observed range or within less than one standard deviation from the mean of those for *C. aztecus*. The M¹ from Simi Valley is smaller than any of those of *C. aztecus* from the San Diego area and is about three and one-half standard deviations from the mean of those of the San Diego sample. It is difficult to determine the significance of this size difference because only five M's of *C. aztecus* are known and such a small sample is not expected

Table 1. Measurements (in mm) of dentition of *Centetodon* sp., cf. *C. aztecus*.

N	Tooth/ dimension	O.R.	Mean	S.D.	C.V.
1	M ¹ A-P	1.49			
1	ANT-TR	1.83			
1	POST-TR	2.03			
2	M ₁ A-P	1.71-1.77	1.74		
2	ANT-TR	1.10-1.24	1.17		
2	POST-TR	0.99-1.06	1.03		
4	M ₂ A-P	1.48-1.75	1.63		
4	ANT-TR	1.00-1.15	1.06		
5	POST-TR	0.83-0.99	0.90	0.07	7.8
1	M ₃ A-P	1.67			
1	ANT-TR	1.05			
1	POST-TR	0.73			

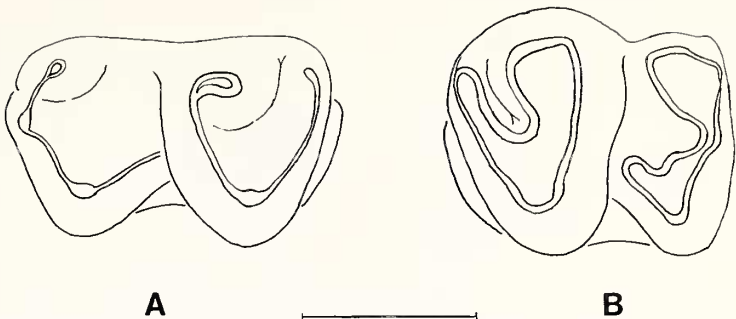


Figure 3. *Sespedectes singularis* Stock, A. RM₁, LACM 132459; B. LM₂, LACM 132458. All occlusal views. Scale = 1 mm.

to include the full range of intraspecific variation. Furthermore, the discrepancies in the comparative upper and lower molar sizes within the Simi Valley sample of *Centetodon* indicate that the sample either represents more than one species or a highly variable species. Until a larger sample from the Sespe Formation is available for adequate analysis and comparison with the San Diego sample, the Simi Valley teeth are herein referred to *C. sp.*, cf. *C. aztecus*, recognizing that this taxon may represent more than one species.

Suborder Erinaceomorpha
Gregory, 1910

Family Dormaaliidae Quinet, 1964

Subfamily Sespedectinae
Novacek, 1985

Genus *Sespedectes* Stock, 1935c

Sespedectes singularis
Stock, 1935c

Figure 3

REFERRED SPECIMENS. Partial dentary with RM₁, LACM 132459; LM₂, LACM 132458.

LOCALITY. LACM 5876.

FAUNA AND AGE. Simi Valley Landfill Local Fauna, late Duchesnean.

DISCUSSION. The two lower molars from LACM 5876 are morphologically indistinguishable from those of *S. singularis*. The measurements of LACM 132458 are 1.96 mm A-P, 1.35 mm ANT-TR, and 1.32 mm POST-TR, and those of LACM 132459 are 1.85 mm A-P, 1.51 mm ANT-TR, and 1.47 mm POST-TR.

These molars are significant because they represent the highest stratigraphic occurrence of *S. singularis* in the Sespe Formation and extend the geologic range of this species into the late Duchesnean.

?Sespedectinae Novacek, 1985

erinaceomorph, gen. and sp. undet.

Figure 4

REFERRED SPECIMENS. RP⁴, LACM 131088; RM², LACM 131091.

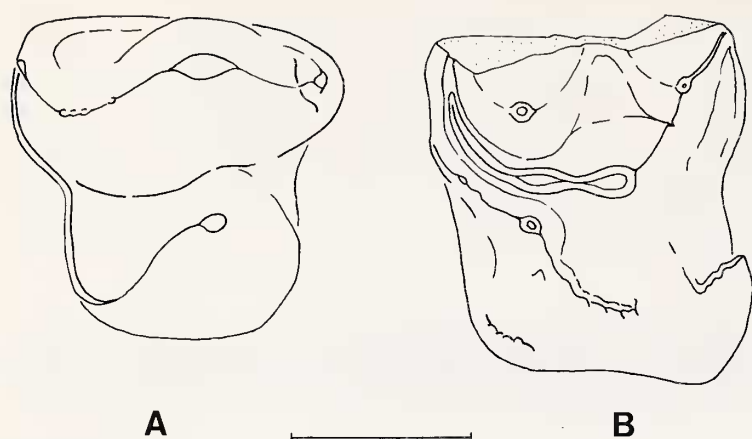


Figure 4. Erinaceomorph, gen. and sp. undet., A. RP⁴, LACM 131088; B. RM², LACM 131091. All occlusal views. Scale = 1 mm.

LOCALITY. LACM 5863.

FAUNA AND AGE. Brea Canyon Local Fauna, late Uintan.

DESCRIPTION. The P⁴ is subtriangular in occlusal outline and the labial surface is straight. The paracone is slightly compressed transversely and taller than the protocone. An incipient metacone is present posterior to the paracone along a sweeping posterior crest of the paracone (= metastylar crest). The parastyle is a small distinct cusp. The posterolingual cingulum extends posteriorly from the protocone and joins the posterior cingulum. The measurements of the P⁴ are 1.86 mm A-P and 1.89 mm ANT-TR.

The partial M² is missing the paracone, metacone, and part of the anterior cingulum. The paracnule is smaller than the metaconule and is connected to the protocone by the preprotocrista. The metaconule is a prominent, relatively isolated cusp. The protocone is a tall, sharp-crested cusp with the postprotocrista extending posterolabially and terminating at the posterior aspect of the metaconule. The hypocone is a well-developed cusp that is connected to the posterior and lingual cingulae. Although only partially represented, the anterior cingulum appears to have been robust. The only measurement that can be estimated for the partial M² is the A-P, which is 1.9 mm.

DISCUSSION. The P⁴ and M² from locality LACM 5863 are morphologically most similar to those of *Sespedectes*, *Proterixoides* Stock, 1935c, and *Crypholestes* (Novacek, 1976). The P⁴ and M² are smaller than those of *Proterixoides*, slightly larger than those of *Sespedectes*, and about the same size as those of *Crypholestes*. They differ from those of *Sespedectes* by having the P⁴ less transversely elongated with a smaller metacone on the metastylar crest and more acute cusps (less bunodont), and the M² with a less bunodont protocone, a much more robust precingulum, a weaker hypocone that is positioned further posteriorly, and a well-developed lingual cingulum between the hypocone and protocone. They differ from those of *Proterixoides* by having the M² with a lingual cingulum present and sharper (less conical) primary

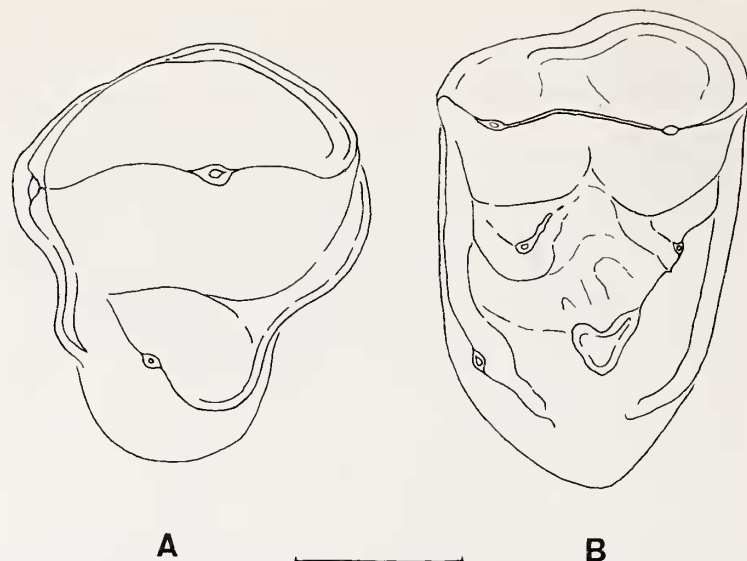


Figure 5. *Dyseolemur pacificus* Stock, A. LP⁴, LACM 131087; B. RM³, LACM 131089. All occlusal views. Scale = 1 mm.

cusps. They differ from those of *Crypholestes* by having the P⁴ less transversely elongated, the M² metaconule more isolated, and an M² lingual cingulum present.

The P⁴ and partial M² from locality LACM 5863 appear to represent a new species of erinaceomorph insectivore most closely related to species of the *Sespedectinae*. However, due to the lack of adequate material, these specimens are referred to erinaceomorph, gen. and sp. undet.

Order Primates Linnaeus, 1758

Family Omomyidae Trouessart, 1879

Genus *Dyseolemur* Stock, 1934a

Dyseolemur pacificus Stock, 1934a

Figure 5

REFERRED SPECIMENS. LP⁴, LACM 131087; RM³, LACM 131089; LP₄, LACM 131090; partial RM₂, LACM 130749.

LOCALITIES. LACM 5616, 5863.

FAUNA AND AGE. Brea Canyon Local Fauna, late Uintan.

DESCRIPTION. The P⁴ (LACM 131087), the first upper premolar from the Sespe Formation referred to *D. pacificus*, is only slightly worn. The paracone is a sharp tall cusp that is slightly compressed transversely. The labial margin of the tooth is convex. The posterolabial aspect of the tooth is swollen and larger than the anterolabial aspect. The preparacrista extends anteriorly from the paracone to the posterior aspect of the tooth and then turns labially to join the labial cingulum. The postparacrista extends posteriorly to the posterior cingulum and then turns labially to join the labial cingulum. A very small metastyle is present at the junction of the postparacrista and the labial cingulum. A small distinct parastyle is present. The protocone is a conical cusp with a sharply pointed apex. A small short preprotocrista extends anterolabially from the

protocone to the base of the paracone. The postproto-crista is a weak crest that extends posteriorly down the posterior surface of the protocone, wherein it joins the posterior cingulum. A small bulge, which appears to represent an incipient hypocone, is present at the junction of the postproto-crista and the posterior cingulum. The precin-gulum is a distinct crest that extends labially from the anterior base of the protocone to the parastyle. The posthypocone crista is robust and extends la-bially from the incipient hypoconal bulge to the anterior base of the paracone, near the point where the preparacrista turns labially. The labial cingulum is complete across the labial surface of the tooth but is distinctly thinner along the medial labial as-pect. The measurements of the P⁴ are 1.81 mm A-P and 2.16 mm TR.

The M³ discovered during the program is well preserved and less worn than the two previously known M³s of *D. pacificus*. It differs from these M³s by the following characters: (1) the metaconule is better developed and slightly more isolated; (2) a connecting crest from the metaconule to the metacone is lacking; and (3) the hypocone is a dis-tinct cusp on the posterior cingulum. The mea-surements of the M³ are 1.88 mm A-P and 2.81 mm TR.

The newly discovered P₄ and partial M₂ are in-distinguishable from previously described P₄s and M₂s (Stock, 1934a; Szalay, 1976; Kelly, 1990) and, therefore, detailed descriptions of these teeth are not warranted. The measurements of the P₄ are 1.72 mm A-P and 1.44 mm TR, and those of the M₂ are 2.03 mm A-P and 2.01 mm ANT-TR.

DISCUSSION. The impact mitigation program has resulted in the recognition of additional spec-imens of the rare primate *D. pacificus*, including the first P⁴ from the Sespe Formation referable to this species. Walsh (1987) assigned a P⁴ from the Mission Valley Formation in the San Diego area to *D. pacificus*, and a comparison of the description of this specimen with the newly discovered Simi Valley specimen appears to substantiate his assign-ment.

Szalay and Delson (1979) regarded *Dyseolemur*, *Washakius* Leidy, 1873, and *Shoshonius* Granger, 1910, to be related because they share the derived character of having mesostylids present on the low-er molars. Szalay and Delson considered *Dyseole-mur* more closely related to *Washakius* than to *Shoshonius* because the upper molars of *Shoshoni-us* possess mesostyles whereas in *Washakius* and *Dyseolemur* they lack mesostyles. Furthermore, Szalay and Delson noted that the shape of the M₁₋₂ talonid notch of *Dyseolemur* and *Washakius* is nearly identical. A close relationship between *Dyse-olemur* and *Washakius* is further supported be-cause the Simi Valley P⁴ of *Dyseolemur* also ex-hibits greater morphological similarity to those of *Washakius* than to those of *Shoshonius*. In *Sho-shonius* a distinct metacone is present on the P⁴, resulting in a reduction of the size of the paracone,

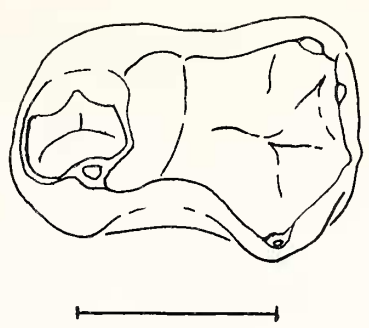


Figure 6. *Uintasorex* sp., cf. *U. montezumicus* Lille-graven, LM₁, LACM 132461, occlusal view. Scale = 0.5 mm.

whereas in *Dyseolemur* and *Washakius* the meta-cone is lacking and the paracone is correspondingly larger. However, the P⁴ of *Dyseolemur* can be easily distinguished from those of *Washakius* by having a much weaker hypocone and better developed postprotoconal fold.

Order ?Primates
Family Microsyopidae
Osborn and Wortman, 1892
Subfamily Uintasoricinae
Szalay, 1969
Genus *Uintasorex* Matthew, 1909
Uintasorex sp.,
cf. *U. montezumicus*
Lillegraven, 1976
Figure 6

REFERRED SPECIMEN. LM₁, LACM 132461.
LOCALITY. LACM 5855.

FAUNA AND AGE. Tapo Canyon Local Fauna, late Uintan.

DISCUSSION. The LM₁ from locality LACM 5855 is morphologically very similar to those of *U. montezumicus* from the Mission Valley Formation, San Diego, California, including the following shared characters: (1) a vestigial paraconid that is posi-tioned very close to the metaconid with the apices of these cusps separated by a very small gap; (2) a sharply curved cristid connecting the protoconid with the paraconid and a curved cristid connecting the protoconid with the metaconid; (3) an enclosed trigonid basin; (4) a small hypoconulid positioned close to the entoconid; and (5) a deeply basined and completely rimmed talonid. The measurements of LACM 132461 are 0.88 mm A-P, 0.51 mm ANT-TR, and 0.63 mm POST-TR.

The LM₁ from Simi Valley is assigned to *U. sp.*, cf. *U. montezumicus* because it differs from those of *U. montezumicus* in its smaller size and by having the widths of the trigonid and talonid slightly small-er relative to the corresponding A-P lengths. The discovery of LACM 132461 represents the first rec-ord of *Uintasorex* from the Sespe Formation.

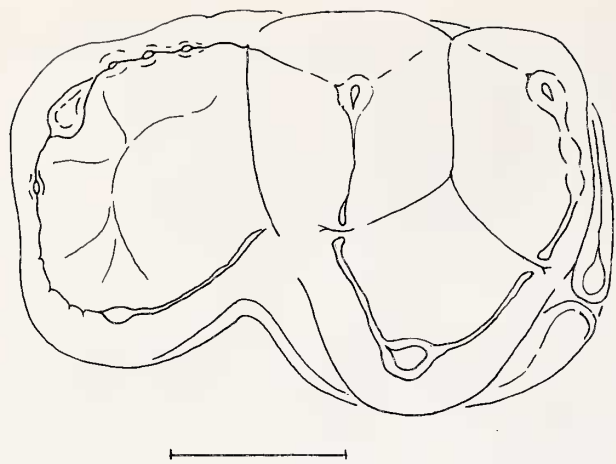


Figure 7. *Miacis* sp. undet., RM₂, LACM 130826, occlusal view. Scale = 1 mm.

Order Carnivora Bowdich, 1758

Family Miacidae Cope, 1880

Genus *Miacis* Cope, 1872

Miacis sp. undet.

Figure 7

REFERRED SPECIMEN. RM₂, LACM 130826.

LOCALITY. LACM 5866.

FAUNA AND AGE. Brea Canyon Local Fauna, late Uintan.

DESCRIPTION. The trigonid of LACM 130826 is moderately elevated above the talonid indicating it is an M₂. The trigonid shelf and the talonid basin are deep and the trigonid is open lingually. The cristid connecting the paraconid and protoconid possesses a distinct carnassial notch. A similar notch is present midway along the cristid that joins the metaconid and protoconid. The paraconid, protoconid, and metaconid are about equal in height. The entoconid and hypoconid are well developed, whereas the pre-entoconid, hypoconulid, and pre-hypoconid are only represented by very small cusps along the talonid cristid. The anterior and posterior labial cingulids are robust. A distinct periconid is present on the anterior labial cingulid. The measurements of LACM 130826 are 3.43 mm A-P, 2.74 mm ANT-TR, and 2.14 mm POST-TR.

DISCUSSION. The RM₂ (LACM 130826) from Simi Valley is most similar to those of *Miacis*, and it is referred to *Miacis* sp. undet. It differs from previously known miacids of the Sespe Formation (*Tapocyon occidentalis*, Stock, 1934b; *Procyonictis progressus* (Stock, 1935b); and *Miacis? hookwayi* Stock, 1934b) by its much smaller size.

Order Rodentia Bowdich, 1821

Family Ischyromyidae Alston, 1876

Reithroparamyinae, Wood, 1962

Genus *Microparamys* Wood, 1959

DISCUSSION. In a very significant paper, Korth (1984) presented a comprehensive review of the early Tertiary evolution and radiation of North

American rodents that provided many new insights into rodent phylogenetic relationships. In this report, Korth (1984) reviewed the taxonomy of *Microparamys* wherein he assigned two new species, *M. scopaiodon* and *M. reginensis*, to the genus. Korth noted that many species originally referred to *Microparamys* are now assigned to other genera. He recognized seven North American species of *Microparamys*: *M. minutus* (Wilson, 1937), *M. tricus* (Wilson, 1940a), *M. dubius* (Wood, 1949), *M. perfossus* Wood, 1974, *M. sp. D* (= *M. woodi* n. sp., this paper), *M. scopaiodon*; and *M. reginensis*. In addition to these species, two informal taxa are referred to *Microparamys*: *M. sp.*, cf. *M. minutus* from the Friars and Mission Valley Formations of the greater San Diego area of California (Lillegraven, 1977), and *M. sp.*, cf. *M. tricus* from the Sespe Formation (this paper). Wood (1959) designated *M. minutus* from the Bridger Formation of Wyoming as the type species of *Microparamys*. The characters that define *Microparamys* have been expanded considerably with the addition of *M. scopaiodon* and *M. reginensis* to the genus. Korth noted that *M. scopaiodon* and *M. reginensis* also exhibit many similarities to the middle Eocene sciuravid *Pauromys* (family Sciuravidae).

Korth (1984) revised the characters that define the Reithroparamyinae and included the following genera in this subfamily: *Reithroparamys* Matthew, 1920, *Acritoparamys* Korth, 1984, *Apatosciuravus* Korth, 1984, *Lophiparamys* Wood, 1962, and *Microparamys*. Korth provided evidence that the reithroparamyines were directly derived from an Asian ctenodactyloid rodent ancestor. In order to determine the phylogenetic relations of *Microparamys* to the other reithroparamyines and to determine if *Microparamys* comprises a monophyletic clade, cladistic analyses were performed at the generic and specific levels using Version 1.5 of the Hennig86 computer program (Farris, 1988) run on a 386 personal computer. The characters and character states used in these analyses are presented in Appendix A. The Asian ctenodactyloid rodent *Cocomys lingchaensis* Li, Chiu, Yan, and Hsieh, 1979, was selected as the outgroup because it is the most primitive rodent known, making it the best taxon available for determining the plesiomorphic character states used in the analyses. *Cocomys* is well known from numerous specimens and has been described in detail by Li et al. (1989).

Korth (1984) assigned *M. scopaiodon* and *M. reginensis* to *Microparamys* based on the following shared characters of these species with primitive ischyromyids and *Microparamys*: (1) the M₂ anterior cingulid is widely separated from the protoconid; (2) the lower molar anterior cingulid arises from the metaconid; (3) the lower molars lack a hypolophid that extends buccally from the entoconid; and (4) the mandibular masseteric fossa extends forward to a level about equal to those of *Microparamys*. Korth also used the above characters to differentiate *M. scopaiodon* and *M. re-*

ginensis from *Pauromys* but recognized that most of these characters are just the plesiomorphic states for primitive ischyromyids. Korth cited the following similarities of *M. scopaiodon* and *M. reginensis* with *Pauromys*: (1) the lophs on the lower molars are of similar height; (2) the P_4 is very reduced; (3) the lower molar mesoconid is anteroposteriorly compressed; (4) the lower molar entoconid is separated from the posterolophid; and (5) the lower molar protoconid is isolated with the long arm of the protoconid extending to the base of the metaconid and paralleling the anterior cingulid. Of these characters, separation of the entoconid from the posterolophid is the plesiomorphic state observed in ctenodactyloid rodents and cannot be used to establish phylogenetic relationships.

In order to determine the phylogenetic relations of *M. scopaiodon* and *M. reginensis* to the sciuravid *Pauromys* and the reithroparamyines, a cladistic analysis including all of these taxa was performed. Character states were based primarily on those of the holotypes and topotypes of each genus. However, in order to avoid using characters that exhibit high levels of parallelism or reversals in the analyses, attempts were also made to consider the character states of the least derived species of each genus. The generic character states were determined from the following species: *Reithroparamys ctenodactylops* Korth, 1984, *Reithroparamys delicatissimus* (Leidy, 1871), *Acritoparamys atavus* (Jepsen, 1937), *Acritoparamys atwateri* (Loomis, 1907), *Acritoparamys francesi* (Wood, 1962), *Lophiparamys murinus* (Matthew, 1918), *Lophiparamys woodi* Guthrie, 1971, *Apatosciuravus bifax* Korth, 1984, *Microparamys minutus*, *Microparamys scopaiodon*, *Microparamys reginensis*, *Pauromys perditus* Troxell, 1923, and *Pauromys* sp. from Powder Wash, Utah, described by Dawson (1968).

Cladistic analysis of *M. scopaiodon*, *M. reginensis*, *Pauromys*, and the reithroparamyines was performed based on the character state matrix presented in Appendix B. The analysis resulted in four equally parsimonious cladograms with lengths of 60 steps and consistency indices of 66 using unweighted characters. The analysis was then repeated using successive weighting of characters, a procedure that has been shown to avoid the excessive weighting of multistate characters relative to binary characters and a means of basing groupings on more reliable characters without making prior decisions on weighting (Goldman, 1988; Farris, 1988). This procedure resulted in cladogram A of Figure 8 as the most parsimonious cladogram with a consistency index of 86. Therefore, cladogram A of Figure 8 is considered to most likely represent the correct relations of the taxa.

Based on cladogram A (Fig. 8), *M. scopaiodon* and *M. reginensis* are united by the following synapomorphies (node 6): (1) the M_{1-2} anterior cingulid is separated from the protoconid by a distinct groove in early wear that disappears with moderate wear to form a connection between the labial terminus

of the anterior cingulid and the protoconid; (2) the M_{1-2} posterolophid is well developed; and (3) the M_{1-2} entoconid is isolated and separated from the posterolophid by a narrow distinct groove. In this analysis, *Pauromys* is the closest sister taxon to *M. scopaiodon* and *M. reginensis*, and these taxa are united by the following synapomorphies (Fig. 8, cladogram A, node 5): (1) the M^{1-2} metaconule is absent or very reduced; (2) the P_4 is extremely reduced relative to the lower molars; (3) a P_4 ectolophid is absent; (4) the M_{1-2} anterior cingulid is separated from the protoconid by a distinct groove or valley and the labial terminus of the anterior cingulid is not connected to the protoconid; (5) the M_{1-2} mesoconid is anteroposteriorly compressed; and (6) the M_{1-2} ectolophids are usually absent. These data indicate that *M. scopaiodon* and *M. reginensis* are more closely related to the sciuravid *Pauromys* than to the reithroparamyines and strongly imply that *M. scopaiodon* and *M. reginensis* are not referable to *Microparamys* (*sensu stricto*). *Microparamys scopaiodon* and *M. reginensis* are known only from fragmentary material and, until additional material is discovered that can provide a more complete analysis of these taxa, they cannot be confidently assigned to any genus or family and are herein referred to as "*Microparamys*," family *incertae sedis*. The analysis also indicates *Apatosciuravus* is the closest sister taxon to *Pauromys*. Korth (1984) noted that *Apatosciuravus* shares many characters with *Microparamys* and sciuravids. Whether *Apatosciuravus* is a reithroparamyine or sciuravid cannot be confidently determined based on the cladistic analysis presented here. *Apatosciuravus* is also known from fragmentary material and, until additional material of this taxon is discovered that can provide a more complete analysis, it is tentatively included in the Reithroparamyinae.

Based on the analysis presented above, the Reithroparamyinae comprises the following genera: *Reithroparamys*, *Acritoparamys*, *Microparamys*, *Lophiparamys*, and *Apatosciuravus*. Cladistic analysis was performed on these genera using the character state matrix presented in Appendix C with the characters unweighted and weighted. This analysis produced a single most parsimonious cladogram with a length of 43 steps and a consistency index of 83 using unweighted characters and 96 using weighted characters (Fig. 9). The analysis indicates that *Reithroparamys*, *Apatosciuravus*, and *Acritoparamys* are successive sister taxa to *Microparamys* and *Lophiparamys*. The reithroparamyines are united by the following synapomorphies (Fig. 9, node 1): (1) the posterior margin of the anterior root of the zygoma is located in line with the anterior margin of the P^4 to the center of the P^4 ; (2) the M^{1-2} metaconule is lingually positioned; (3) the M^{1-2} hypocone is well developed; (4) the anterior termination of the masseteric fossa is located in line between the middle of the posterior half of the M_2 to the middle of M_3 ; (5) the P^4 is

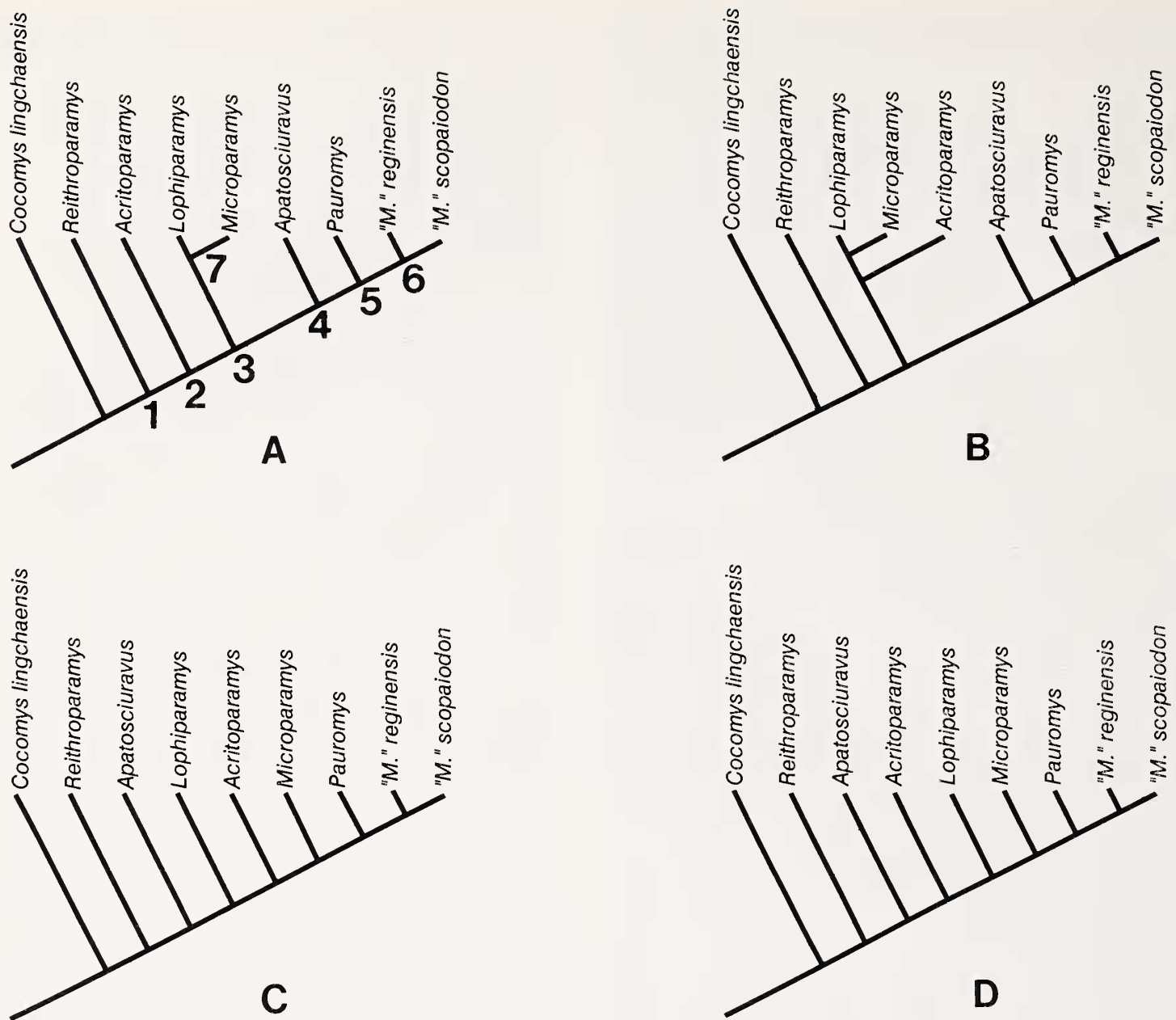


Figure 8. A-D. Four equally most parsimonious cladograms (length of 60 steps, consistency index of 66) of genera discussed in text produced using character state matrix presented in Appendix B with characters unweighted. With weighted characters, cladogram A becomes the most parsimonious (consistency index of 86). In cladogram A, *Pauromys* is closest sister taxon to "*Microparamys*" *scopaiodon* and "*M.*" *reginensis*, united at node 5 by following list of ancestral synapomorphies. Within the parentheses, number to left of colon denotes character number and to right of colon character state of hypothesized ancestor. Node 5: anterior termination of masseteric fossa is located in line between anterior end of M_2 to posterior root of M_1 (2:4); M_1^{1-2} metaconule absent or very reduced (11:4-5); P_4 extremely reduced in size relative to lower molars (16:3); P_4 ectolophid absent (18:0); M_{1-2} mesoconid anteroposteriorly compressed (24:1); M_{1-2} anterior cingulid separated from protoconid by distinct groove or valley and labial terminus of anterior cingulid not connected to protoconid (26:1); M_{1-2} ectolophids usually absent (36:1).

molariform with two buccal cusps (paracone and metacone) and a distinct hypocone; (6) the P_4 ectolophids are usually developed as complete cristids or almost complete cristids extending from the mesoconid to the protoconid and hypoconid; (7) the P_4 hypoconid is well developed; (8) the P_4 postero-lophid is well developed; (9) the P_4 protoconid is usually absent or vestigial; and (10) the M_{1-2} protoconid is connected or nearly connected to ectolophid, and the posterior arm of protoconid is short or if developed is usually directed towards the middle of the metaconid or further forward, and the posterior arm of the protoconid is not parallel with the anterior cingulid. Additional synapomorphies noted by Korth (1984) that may unite the reithroparamyines, but not included in the cladistic analysis because their character states are un-

known for several genera, are: (1) the auditory bullae are enlarged and cossified with the skull and (2) the posterior margin of the nasal bones extends further posteriorly than that of the premaxillaries. In this analysis, *Microparamys* and *Lophiparamys* are closest sister taxa based on the putative synapomorphy (Fig. 9, node 4) of crenulated cheek teeth enamel. Based on the cladistic analysis, no autapomorphies can presently be identified for the reithroparamyines indicating they may represent a paraphyletic group. However, the lack of identifiable autapomorphies may also be due to the fact that many members of this group are poorly known.

Removal of "*M.*" *scopaiodon* and "*M.*" *reginensis* from *Microparamys* results in the following species assigned to the genus: *M. minutus*; *M. sp.*, cf. *M. minutus*; *M. dubius*; *M. tricus*; *M. sp.*, cf.

M. tricus; *M. perfossus*; and *M. woodi* n. sp. Cladistic analysis of these species was performed using the character state matrix presented in Appendix D with the characters unweighted and weighted. Two equally parsimonious cladograms were produced using unweighted characters with lengths of 53 steps and consistency indices of 77 (Fig. 10A–B). With weighted characters, cladogram A (Fig. 10) becomes the most parsimonious with a consistency index of 92.

Based on cladogram A (Fig. 10) the following suite of synapomorphies (node 1) are shared by the species of *Microparamys* and characterize the genus: (1) the posterior margin of the anterior root of the zygoma is located in line with the anterior margin of the P⁴; (2) the anterior termination of the masseteric fossa is located in line with the middle of M₁; (3) size is small; (4) the cheek teeth enamel is weakly to moderately crenulated; (5) the P₄ mesoconid is weakly developed; (6) a P₄ ectolophid is present; (7) the P₄ hypoconid is well developed; (8) the P₄ posterolophid is well developed; (9) the M₁₋₂ anterior cingulid is well developed as a long distinct cristid; (10) the M₁₋₂ anterior cingulid is separated from the protoconid by a distinct groove or valley and the labial terminus of the anterior cingulid is not connected to the protoconid; (11) the M₁₋₂ posterolophid is well developed; (12) the M₁₋₂ hypoconulid is usually present as a moderately well-developed, often elongated, cuspule formed along the posterolophid; and (13) the M₁₋₂ entoconid is isolated and separated from the posterolophid by a narrow distinct groove. The only autapomorphic characters identified that indicate *Microparamys* is a monophyletic clade are the forward positioning of the zygoma and masseteric fossae and the distinct arrangement of the anterior cingulid and the protoconid (numbers 1, 2, and 9, above). Three species groupings are indicated by the analysis: (1) the *minutus* group, including *M. minutus* and *M. sp.*, cf. *M. minutus*; (2) the *woodi* group, including *M. woodi* and *M. perfossus*; and (3) the *tricus* group, including *M. tricus*, *M. sp.*, cf. *M. tricus*, and *M. dubius*. The synapomorphy (node 2) that unites the *minutus* group is a strongly developed P₄ mesoconid. The synapomorphies (node 4) that unite the *woodi* group are as follows: (1) the occlusal patterns in the M¹⁻² protoconal and hypoconal regions are U-shaped; (2) an M² mesolophid is present as a distinct crest originating near the apex of the protocone and extending lingually into the central basin of the tooth; (3) an M₁₋₂ hypoconulid is lacking; and (4) the M₁₋₂ entoconid is connected to the posterolophid. The synapomorphies (node 5) that unite the *tricus* group are: (1) the M¹⁻² postproto-crista is absent or poorly developed and (2) a small distinct cuspule is developed on the labial terminus of the M₁₋₂ anterior cingulid.

The cladistic analyses presented here are regarded as preliminary because many of the taxa are poorly known, the sample sizes are small, and the intraspecific variation of certain characters is not

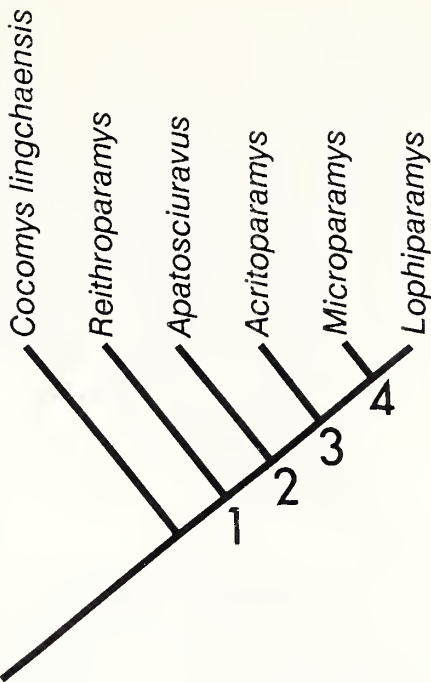


Figure 9. Single most parsimonious cladogram (length of 43 steps, consistency index of 83 with unweighted characters and 96 with weighted characters) produced for genera comprising the Reithroparamyinae using character state matrix presented in Appendix C. The cladogram is supported by the following list of ancestral synapomorphies. Within the parentheses, number to left of colon denotes character number and to right of colon character state of hypothesized ancestor. Node 1: posterior margin of anterior root of zygoma located in line with center of P⁴ (1:1); anterior termination of masseteric fossa is located in line between posterior half to middle of M₂ (2:1); P⁴ molariform with two buccal cusps (paracone and metacone) and distinct hypocone (7:1); M¹⁻² metaconule positioned lingually and not in close association with metacone (12:1); M¹⁻² hypocone well-developed cusp (14:1); P₄ slightly reduced relative to lower molars (16:1); P₄ ectolophid present, weakly developed (18:1); P₄ hypoconid well developed (19:1); P₄ posterolophid present, well developed (20:1); P₄ protoconid usually absent or vestigial (21:1); M₁₋₂ protoconid not isolated (30:0); M₁₋₂ ectolophids usually present with one or both cristids complete or nearly complete (36:0). Node 2: M¹⁻² metaconule single, moderately reduced cusp (11:1); M₁₋₂ anterior cingulid moderately to well-developed cristid connected to metaconid (27:1); M₁₋₂ hypoconulid present as moderately well developed, often elongated, cuspule formed along posterolophid (34:1). Node 3: anterior termination of masseteric fossa is located in line between middle of M₂ to center of anterior half of M₂ (2:2–3); M₁₋₂ posterolophid well developed (32:1); M₁₋₂ entoconid isolated and separated from posterolophid by narrow distinct groove (35:1). Node 4: cheek teeth weakly to moderately crenulated (4:1); M¹⁻² protoconule moderately reduced as elongated cusp (10:1); M₁₋₂ anterior cingulid separated from protoconid by distinct groove or valley and labial terminus of anterior cingulid not connected to protoconid (26:1).

adequately known, especially quantitative characters. However, whenever possible, an attempt was made not to use characters that have been shown by other investigators to be highly variable (e.g., Lillegraven, 1977). The analyses presented here help to clarify the characterization of the genus *Microparamys* and provide a basis for future phyloge-

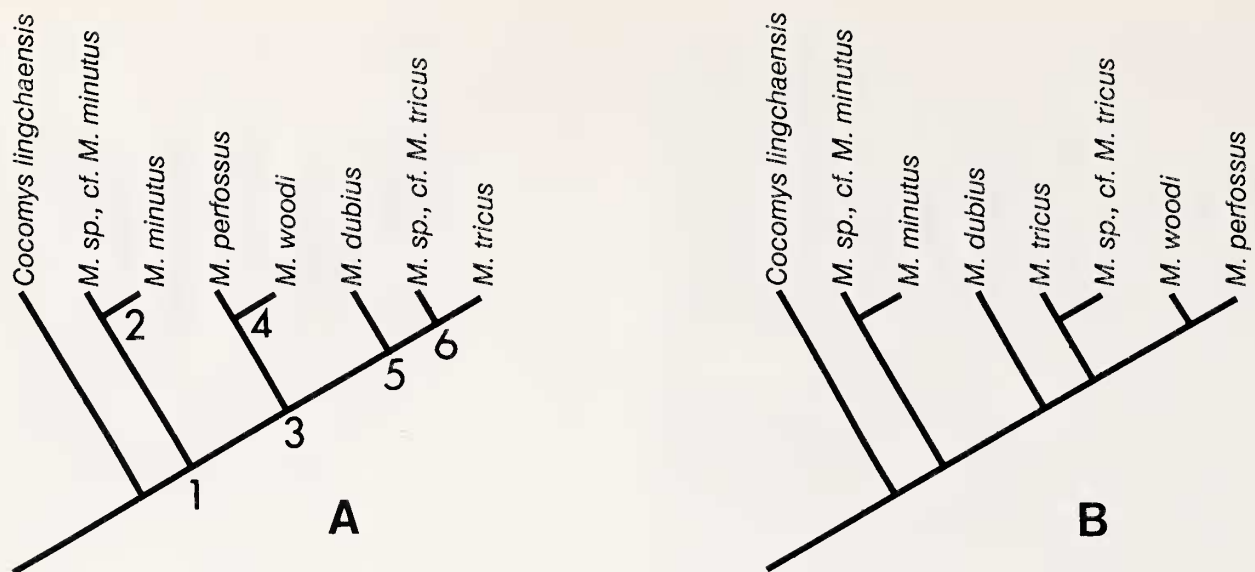


Figure 10. A–B. Two equally most parsimonious cladograms (length of 53 steps, consistency index of 77) of species of *Microparamys* produced using character state matrix presented in Appendix D with characters unweighted. With weighted characters, cladogram A becomes the most parsimonious with a consistency index of 92. Cladogram A is supported by the following list of ancestral synapomorphies. Within the parentheses, number to left of colon denotes character number and to right of colon character state of hypothesized ancestor. Node 1: posterior margin of anterior root of zygoma is located in line with anterior margin of P^4 (1:2); anterior termination of masseteric fossa is located in line with middle of M_1 (2:5); cheek teeth weakly to moderately crenulated (4:1); size small (5:1); P^4 molariform with two buccal cusps (paracone and metacone) and distinct hypocone (7:1); M^{1-2} metaloph and protoloph incomplete (9:1); M^{1-2} single moderately reduced metaconule usually present as relatively distinct cusp (11:1); P_4 mesoconid present, weakly developed (17:1); P_4 ectolophid usually developed as a complete cristid or almost complete cristid extending from mesoconid to protoconid and hypoconid (18:1); P_4 hypoconid well developed (19:1); P_4 posterolophid well developed (20:1); M_{1-2} anterior cingulid well developed as long, distinct cristid (25:1); M_{1-2} separated from protoconid by distinct groove or valley and labial terminus of anterior cingulid not connected to protoconid (26:1); M_{1-2} posterolophid well developed (32:1); M_{1-2} hypoconulid present as moderately well-developed, often elongated, cuspule formed along posterolophid (34:1); M_{1-2} entoconid isolated and separated from posterolophid by narrow distinct groove (35:1). Node 2: P_4 mesoconid strongly developed (17:2). Node 3: M_{1-2} anterior cingulid separated from protoconid by distinct groove or valley and connected to protoconid by small but relatively persistent thin cristid originating from near labial terminus of anterior cingulid (26:3). Node 4: M^{1-2} occlusal patterns U-shaped in hypoconal and protoconal regions (8:1); M^{1-2} metaconule doubled as two small reduced cuspules (11:2); M^2 mesolophid present (15:1); M_{1-2} hypoconulid absent (34:3); M_{1-2} entoconid connected to posterolophids (35:2). Node 5: M^{1-2} postprotocrista absent or poorly developed (13:0); M_{1-2} labial terminus of anterior cingulid cuspsate (28:1). Node 6: M^{1-2} metaconule doubled as two well-developed cuspules (11:3); P_4 slightly reduced relative to lower molars (16:1); P_4 protoconid usually absent or vestigial (21:1).

netic investigations of this little-known group of rodents.

Microparamys woodi new species

Figure 11, Tables 2 and 3

Paramys cf. *minutus* Wilson, 1940a:72, pl. 1, figs. 10–11.

Microparamys sp. D Wood, 1962:165–166, figs. 55G–H.

HOLOTYPE. RM², LACM 130820.

TYPE LOCALITY. LACM 5857.

HYPODIGM. LdP⁴, LACM 133988; 3RP⁴s, LACM 130821, 132415, 132463; LP⁴, LACM 132414; LM¹, LACM 130819; 2RM¹s, LACM 132422, 133989; 3LM²s, LACM 132416, 132464, 132467; RM², LACM(CIT) 2155; LP⁴, LACM 130822; 4RP⁴s, LACM 130823, 132417, 132466, 133990; 2RM¹s, LACM 130818, 133991; 2LM¹s, LACM 132471, 132651; 2LM²s, LACM 130824, 132472; RM², LACM(CIT) 2156; LM³, LACM 132468.

DISTRIBUTION, FAUNAS, AND AGE. Localities LACM 5661, 5855, 5857, 5860, 6081, lo-

cality LACM(CIT) 180; Tapo Canyon and Brea Canyon Local Faunas; late Uintan.

ETYMOLOGY. Named in honor of Albert E. Wood, formerly of the Amherst College, in recognition of his contributions to our understanding of *Microparamys*.

DIAGNOSIS. *Microparamys woodi* is distinguished by having the following suite of characters: (1) small ischyromyid; (2) cheek teeth enamel crenulated; (3) upper cheek teeth with protoloph and metalophs usually complete, occlusal patterns in the protoconal and hypoconal regions U-shaped, metaconule often doubled as two small cusps on metaloph, and tendency for development of small accessory crest originating from protoloph and extending anteriorly towards the anterior cingulum that occasionally results in division of valley between the anterior cingulum and protoloph into labial and lingual portions; (3) upper molars with mesostyles and from one to two mesolophs; (4) P_4 with moderately developed protoconid, weakly developed metaconid, and well-developed posterolophid; and (5) lower molars with metalophid complete, “mesolophids” present, posterolophid well developed and connected to entoconid, valley be-

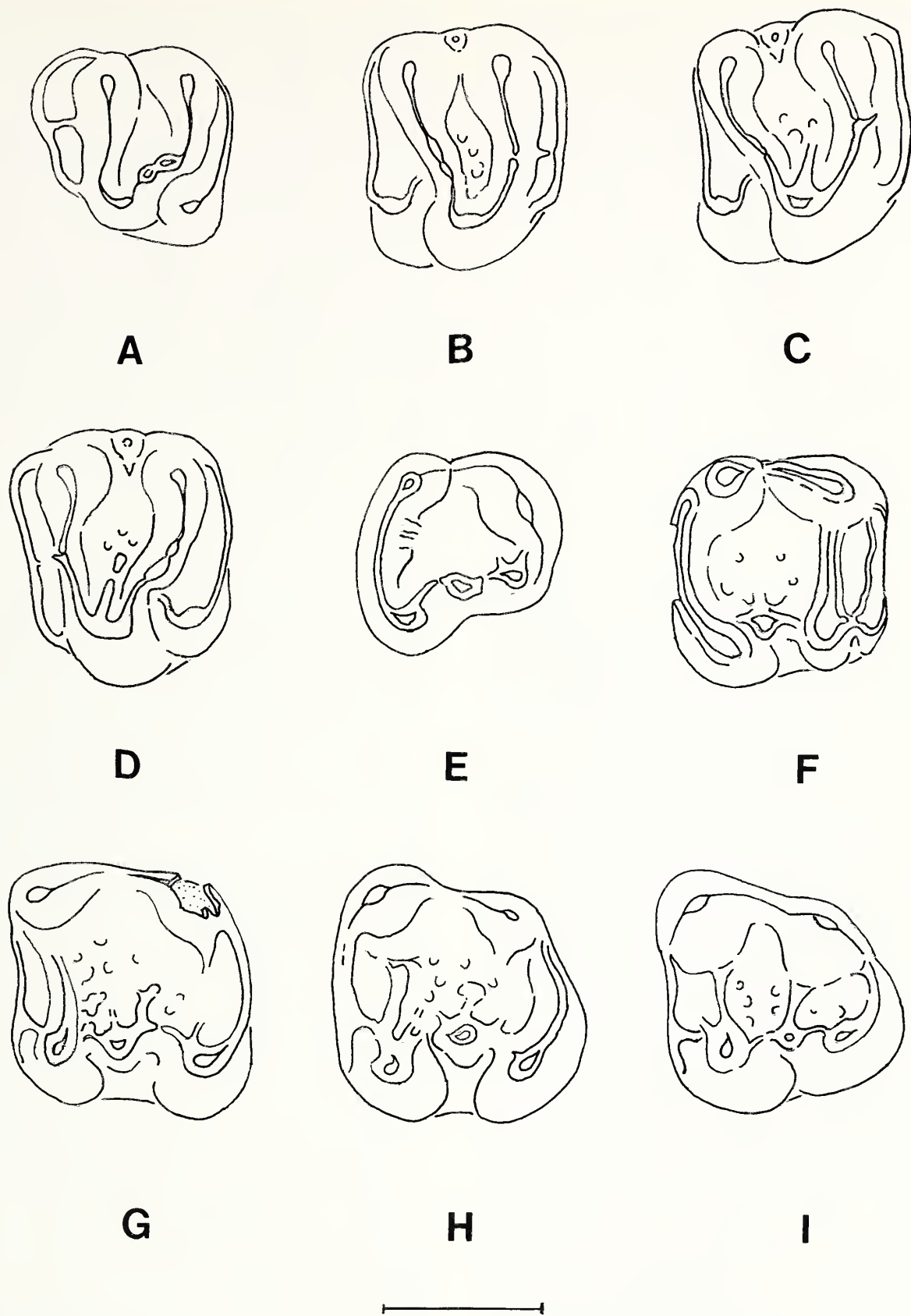


Figure 11. *Microparamys woodi* new species, **A.** LdP⁴, LACM 133988; **B.** RP⁴, LACM 132415; **C.** LM¹, LACM 130819; **D.** holotype, RM², LACM 130820; **E.** RP₄, LACM 130823; **F.** RM₁, LACM 130818; **G.** LM₂, LACM 130824; **H.** LM₃, LACM 131472; **I.** LM₃, LACM 132468. All occlusal views. Scale = 1 mm.

tween anterior cingulid and protoconid moderately developed with small accessory cristid extending across valley connecting protoconid and anterior cingulid, and hypoconulids absent. Differs from *Microparamys minutus* (Wilson, 1937) and *M. sp.*, cf. *M. minutus* (Lillegraven, 1977) by having the following characters: (1) teeth larger; (2) M¹⁻² with mesostyles present, mesolophs more strongly developed, and connection of anterior crest of hypocone to metaloph stronger; and (3) lower molar hypolophids more developed. Differs from *M. triicus* (Wilson, 1940a) by having the following char-

acters: (1) teeth smaller; (2) M¹⁻² with relatively smaller mesostyles, less developed and bulbous protoconules and metaconules, less tendency for multiplication of metaconules, greater tendency for multiplication of mesolophs, and greater tendency for development of an accessory crest uniting protoloph and anterior cingulum; and (3) lower molars with slightly less separation of protoconid and anterior cingulid. Differs from *M. dubius* (Wood, 1949) by having the following characters: (1) P⁴ with better developed metaconule, a mesostyle, and larger hypocone; (2) M¹⁻² with lingually directed crests

Table 2. Measurements (in mm) of upper dentition of *Microparamys woodi* new species.

N	Tooth/ dimension	O.R.	Mean	S.D.	C.V.
1	dP ⁴ A-P	1.29			
1	ANT-TR	1.07			
1	POST-TR	1.30			
4	P ⁴ A-P	1.15–1.24	1.21		
4	ANT-TR	1.38–1.54	1.46		
4	POST-TR	1.33–1.45	1.39		
3	M ¹ A-P	1.33–1.42	1.38		
3	ANT-TR	1.45–1.55	1.51		
3	POST-TR	1.40–1.47	1.44		
5	M ² A-P	1.35–1.48	1.42	0.05	3.5
5	ANT-TR	1.58–1.73	1.63	0.06	3.7
4	POST-TR	1.44–1.56	1.49		

from mesostyles and U-shaped protocones and hypocones; and (3) lower molars with “mesolophids” present and hypolophids that are less developed and posterolabially directed. Differs from *M. perfossus* Wood, 1974, by having the following characters: (1) P⁴ and M¹ hypocones less separated from protocones; (2) M¹⁻² with better developed metalophs and greater tendency for multiplication of metaconules; (3) P₄ less anteroposteriorly elongated and protoconid smaller; and (4) lower molars with posterolabially directed hypolophids and lacking long cristid from entoconid toward hypoconid. Differs from “*M.*” *reginensis* Korth, 1984, by having the following characters: (1) teeth much larger; (2) lower molar lingual extension of mesoconid lacking and mesoconid not anteroposteriorly compressed; (3) occlusal outline of M₃ less rectangular; and (4) enamel more crenulated in basins. Differs from “*M.*” *scopaiodon* Korth, 1984, by having the following characters: (1) P₄ much larger, and larger relative to molars; (2) P₄ occlusal pattern more complex and protoconid more reduced; (3) lower molars with mesoconids not anteroposteriorly compressed, lacking a long posterior arm of protoconid extending to base of metaconid, and entoconids connected to posterolophids; and (4) enamel more crenulated in basins.

DESCRIPTION. Only one deciduous P⁴ of *M. woodi* has been recovered from the Sespe Formation. The dP⁴ is subtriangular in occlusal outline and moderately molariform. The protocone is the largest primary cusp, and the metacone and paracone are about equal in size. A thin crest is present along the labial aspect of the tooth that connects the metacone with the paracone. The preprotocrista extends anterolabially to form a protoloph and the postprotocrista extends posterolabially to form a metaloph. Two small distinct metaconules are present along the crest of the metaloph. The anterior cingulum is robust. A very low accessory crest is present between the protoloph and the anterior cingulum that divides the valley separating

Table 3. Measurements (in mm) of lower dentition of *Microparamys woodi* new species.

N	Tooth/ dimension	O.R.	Mean	S.D.	C.V.
5	P ₄ A-P	1.24–1.41	1.34	0.07	5.5
5	ANT-TR	0.97–1.08	1.05	0.05	4.7
5	POST-TR	1.18–1.39	1.30	0.09	6.8
3	M ₁ A-P	1.40–1.46	1.43		
4	ANT-TR	1.30–1.51	1.41		
3	POST-TR	1.39–1.49	1.44		
3	M ₂ A-P	1.44–1.58	1.52		
3	ANT-TR	1.42–1.55	1.49		
3	POST-TR	1.49–1.58	1.52		
1	M ₃ A-P	1.47			
1	ANT-TR	1.35			
1	POST-TR	1.21			

these structures into labial and lingual portions. The posterior cingulum is well developed and extends lingually from the labial aspect of the metacone to the level of the protocone wherein it terminates in a well-defined bulge or hypocone.

The P⁴ is subquadrate in occlusal outline with the protocone and hypocone separated by relatively deep valleys. A small distinct mesostyle is present between the paracone and metacone. One or two metaconules may be present as small cusps or bulges on the metaloph. The protoconule is usually a distinct small bulge on the protoloph. The protoloph is a complete crest except for a small cleft about midway along the protoloph at the point where a small accessory crest projects anteriorly from the protoloph towards the anterior cingulum. The metaloph is a low complete crest. The preprotocrista, postprotocrista, and the protocone form a U-shaped wear pattern in the protoconal region. A mesoloph is absent in all known P⁴s. The anterior cingulum is well developed and a slight enlargement is present at the lingual terminus. The posterior cingulum is well developed and extends lingually from the posterolabial aspect of the metacone to terminate in a well-developed hypocone. A crest from the hypocone extends anterolabially to terminate just short of the middle of the metaloph and this crest along with the posterior cingulum and the hypocone results in a U-shaped wear surface in the hypoconal region. The enamel is moderately crenulated in the basins of the tooth.

The first two upper molars are similar in morphology to the P⁴ except for the following differences. The occlusal outline is more quadrate in shape. The mesostyle has a small spur that extends lingually into the central basin of the tooth. The parastylar region is larger or more inflated. Mesolophs are always present and may vary from a single crest to two separate crests that extend labially from the apex of the protocone, between the preprotocrista and postprotocrista, into the central basin to terminate about half way towards the labial as-

pect of the tooth. The anterior cingulum is more developed, and a lingual terminal bulge of the anterior cingulum may be present or absent. The accessory crest that originates from the protoloph occasionally extends anteriorly to join with the anterior cingulum; this results in a division of the valley between the anterior cingulum and the protoloph into labial and lingual portions. However, this accessory crest is more commonly absent, or it only forms a partial divider that extends anteriorly from the protoloph a very short distance into the intervening valley. The enamel is more crenulated in the basins of the first two upper molars.

The P_4 is subrectangular in occlusal outline. The metaconid is the largest and tallest cusp. A small cristid extends posteriorly from the apex of the metaconid towards the entoconid where it terminates just anterior to the entoconid. The protoconid is a low bunodont cusp and the smallest primary cusp. The metalophid is a small low cristid that connects the metaconid and protoconid. The mesoconid is weakly developed as a small rounded bulge or cusp, and a mesolophid is lacking. The entoconid is slightly taller than the hypoconid, and these cusps are connected by a complete, posteriorly convex posterolophid. The anterior cingulid is a convex cristid extending from the metaconid to the anterolabial aspect of the protoconid. The metalophid is a small cristid originating from the apex of the protoconid and extending anterolingually towards the protoconid. The enamel is usually crenulated in the basins of the tooth.

The first two lower molars have rectangular occlusal outlines. Incipient metastylids may be present as very small cuspules on the lingual cristid connecting the metaconid and entoconid. The metalophid is a complete low cristid that connects the metaconid and protoconid. The mesoconids are well developed. "Mesolophids" are usually present and can vary from a single to as many as three low spurs extending lingually from the mesoconid into the central basin of the tooth. A small short spur is present that extends labially from the entoconid into the basin of the tooth. The hypolophid is usually a short posterolabially directed cristid. The anterior cingulid extends lingually from the base of the metaconid to the level of the protoconid and a moderately developed valley separates the anterior cingulid from the protoloph and protoconid. A small accessory cristid extends from the protoconid across this valley to the anterior cingulid. The posterolophid is well developed and connects the hypoconid with the entoconid. The enamel is crenulated in the basins of the tooth.

Only two M_3 s of *M. woodi* have been recovered during the impact mitigation program. The M_3 s are morphologically very similar to the first two lower molars except that they have more robust and curved posterolophids. Both M_3 s lack incipient mesostylids, but this may not be a diagnostic character for the M_3 because the occurrence of mesostylids is variable in the first two lower molars.

DISCUSSION. Wilson (1940a) referred two isolated teeth, an upper and a lower molar, from the Sespe Formation at locality LACM(CIT) 180 to *Paramys* cf. *minutus*. Wood (1962) reevaluated the phylogenetic status of these two teeth and assigned them to an informal taxon, *Microparamys* sp. D, noting that they represented a very distinct species of *Microparamys*. Lillegraven (1977), in agreement with Wood, regarded the teeth of *M. sp. D* a new species but, like Wood, was reluctant to formally name a new taxon until a better sample was available from the Sespe Formation. The new material of *M. sp. D* discovered during the program at the Simi Valley Landfill has resulted in a better characterization of this taxon and allows the assignment of this sample to the new species *M. woodi*.

Because of the larger sample of *M. woodi* now available, the intraspecific variation of the teeth can be evaluated. The two most variable characters of the teeth of *M. woodi* are: (1) the degree of the development of an accessory crest extending from the protoloph to the anterior cingulum (= anterior cingulum-protoloph crest) and (2) the development of mesolophs and "mesolophids" in the upper and lower molars, respectively. The anterior cingulum-protoloph crest is usually absent or represented only by a partial crest extending anteriorly from the protoloph part way across the transverse valley that separates the anterior cingulum from the protoloph. Occasionally, the anterior cingulum-protoloph crest is complete across the intervening valley and connects the anterior cingulum with the protoloph, resulting in a division of the valley into labial and lingual portions. Walsh (1987) also found the occurrence of anterior cingulum-protoloph crests to be highly variable in a sample of *Microparamys* teeth from the Mission Valley Formation of the San Diego area in California. In the upper molars, one or two mesolophs may be present, extending labially from the apex of the protocone into the central transverse valley. In the lower molars, from one to three "mesolophids" may be present as separate low cristids extending lingually from the mesoconid into the central basin of the tooth.

Many investigators have discussed in detail the probable relations of *M. woodi* (= *M. sp. D*) to other species of *Microparamys* (Wilson, 1940a; Wood, 1962, 1974; Dawson, 1966, 1974; Lillegraven, 1977; Korth, 1984; Walsh, 1987). Wood (1974) regarded *M. woodi* as most similar to *M. perfossus* of the Porvenir Local Fauna, Vieja-Ojinaga area, Texas, wherein both species have U-shaped upper molar occlusal patterns in the protoconal and hypoconal regions. Additional shared characters of *M. woodi* and *M. perfossus* indicating a close relationship are as follows: (1) the M^2 mesoloph is well developed; (2) the M_{1-2} entoconid is connected to the posterolophid; and (3) the M_{1-2} hypoconulid is absent or vestigial. Even though the above synapomorphies unite *M. woodi* and *M. perfossus* into a species group, *M. woodi* can be easily distinguished from *M. perfossus* by the following

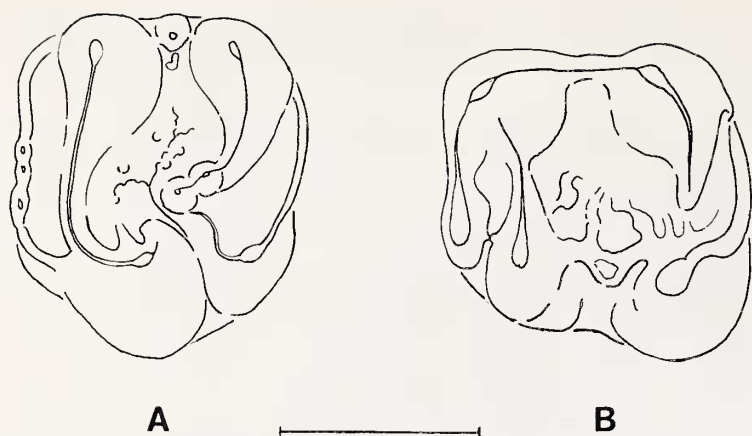


Figure 12. *Microparamys* sp., cf. *M. tricus* (Wilson), A. LM², LACM 130809, B. LM₁, LACM 130810; C. LM₂, LACM 130816; D. RM₃, LACM 130814. All occlusal views. Scale = 1 mm.

differences: (1) the P⁴ and M¹ hypocones are less separated from the protocones; (2) the M¹⁻² meta-lophs are more developed with a greater tendency for multiplication of the metaconules; (3) the P₄ is less anteroposteriorly elongated with a relatively smaller protoconid; and (4) the lower molar hypo-lophids are less developed and extend posterolabially.

Microparamys sp., cf. *M. tricus*
(Wilson, 1940)

Figure 12, Table 4

REFERRED SPECIMENS. RM¹, LACM 130812; LM², LACM 130809; LM₁, LACM 130810; RM₁, LACM 130815; LM₂, LACM 130816; RM₃, LACM 130814.

LOCALITIES. LACM 5866, 5869.

FAUNA AND AGE. Brea Canyon Local Fauna, late Uintan.

DISCUSSION. The *Microparamys* teeth from localities LACM 5866 and 5869 are morphologically very similar to those of *M. tricus* from the early Duchesnean Pearson Ranch Local Fauna of the Sespe Formation. However, these teeth differ from those of *M. tricus* by having the following characters: (1) the teeth are smaller; (2) the M² postprotocrista is much more weakly developed and separated from the metaconal region by a labial continuation of the valley that separates the protocone from the hypocone; (3) the lingually directed crest from the mesostyle in the upper molars is slightly less developed; (4) the M₂ hypolophid is slightly less robust; (5) the M₁₋₂ anterior cingulid has a larger, more prominent cuspule at its labial termination; and (6) the M₃ postprotocristid is less developed. The teeth of *M. sp.*, cf. *M. tricus* are distinguished from those of *M. woodi* by having the following characters: (1) M¹⁻² with larger mesostyles, more bulbous protoconules and metaconules, a greater tendency for multiplication of the metaconules, less tendency for multiplication of mesolophs, and usually lacking the low crest that unites the protocone and the anterior cingulum and

(2) lower molars with slightly greater separation of the protoconid and the anterior cingulid.

The samples of *Microparamys* teeth from the late Uintan Brea Canyon Local Fauna are slightly less derived, as indicated by their less developed postprotocristae, postprotocristids, mesostylar lingual crests, and hypolophids, than those of *M. tricus* and are therefore assigned to *M. sp.*, cf. *M. tricus*.

Lillegraven (1977) assigned 10 isolated teeth from the latest Uintan or earliest Duchesnean Camp San Onofre Local Fauna of the ?Santiago Formation, Camp Pendleton Marine Corps Base, California, to *M. tricus*. Lillegraven noted that even though the Camp San Onofre samples of *Microparamys* teeth are consistently smaller, they are indistinguishable morphologically from those of *M. tricus* from the Pearson Ranch Local Fauna. The teeth of *M. sp.*, cf. *M. tricus* are the same size as those of *M. tricus* from the Camp San Onofre Local Fauna but have less developed postprotocristae, postprotocristids, mesostylar lingual crests, and hypolophids. These character states indicate that *M. sp.*, cf. *M. tricus* is less derived than *M. tricus* from the Camp San Onofre Local Fauna. A single evolutionary lineage is probably represented by the *Microparamys* samples discussed above, wherein the late Uintan *M. sp.*, cf. *M. tricus* from the Brea Canyon Local Fauna was probably ancestral to the latest Uintan or earliest Duchesnean *M. tricus* from the Camp San Onofre Local Fauna, and the latter then gave rise to the larger early Duchesnean *M. tricus* from the Pearson Ranch Local Fauna.

Genus *Leptotomus* Matthew, 1910

Leptotomus sp. undet.

Figure 13

REFERRED SPECIMEN. LM₃, LACM 131465.
LOCALITY. LACM 5876.

FAUNA AND AGE. Simi Valley Landfill Local Fauna, late Duchesnean.

DESCRIPTION. The LM₃ is well worn, anteroposteriorly elongated, and the occlusal outline is subrectangular. The labial surface of the protoconid is missing. The anterior cingulid (= anterolophid) is a robust cristid that connects the metaconid with the protoconid. A small metalophid is present and projects lingually from the protoconid into the anterior basin of the tooth. The hypolophid is a continuous cristid between the entoconid and the hypoconid. The ectolophid is complete and markedly curved. The posterior cingulid (= posterolophid) is robust and extends lingually from the posterolabial aspect of the tooth to the entoconid, where it is only separated from the entoconid by a small cleft. The measurements of LACM 131465 are 3.06 mm A-P, 2.66 mm ANT-TR (estimated), and 2.67 mm POST-TR.

DISCUSSION. The Simi Valley tooth (LACM 131465) appears most similar to those of *Leptotomus guildayi* Black, 1971, and *L. sp.*, near *L.*

Table 4. Measurements (in mm) of specimens of *Microparamys* sp., cf. *M. tricus*.

Specimen	Tooth/dimension	
LACM 130812	RM ¹ A-P	1.55 (estimated)
	TR	—
LACM 130809	LM ² A-P	1.69
	TR	1.83
LACM 130810	LM ₁ A-P	1.69
	ANT-TR	1.50
	POST-TR	1.71
LACM 130815	RM ₁ A-P	1.54
	ANT-TR	1.43
	POST-TR	1.59
LACM 130816	LM ₂ A-P	1.75
	ANT-TR	1.68
	POST-TR	1.77
LACM 130814	RM ₃ A-P	1.89
	ANT-TR	1.71
	POST-TR	1.50

guildayi (Black, 1971) of the Badwater Localities 5, 6, and 15 from the ?Wagon Bed Formation of Wyoming by having the following shared characters: (1) the metalophid extends from the protoconid into the central basin of the tooth but does not connect with the metaconid; (2) the hypolophid is complete; (3) the posterolophid is prominent and separated only slightly from the entoconid; and (4) the ectolophid is markedly curved. The Simi Valley tooth differs from those of *L. guildayi* and *L. sp.*, near *L. guildayi* by its smaller size and by having a slightly less developed metalophid and a vestigial mesoconid.

The tooth from Simi Valley also exhibits some characters that are similar to those of species of *Rapamys*, including a prominent posterolophid, markedly curved ectolophid, incomplete metalophid, and complete hypolophid. However, the Simi Valley tooth differs from those of *Rapamys* by lacking the wide separation of the posterolophid and the entoconid.

The Simi Valley specimen appears to be most closely related to *L. guildayi* and *L. sp.*, near *guildayi*. However, due to the lack of adequate material for species identification, it is herein assigned to *Leptotomus* species undetermined.

Family ?Ischyromyidae

Genus *Eohaplomys* Stock, 1935a

Eohaplomys matutinus Stock, 1935a

Figure 14

REFERRED SPECIMEN. RM¹, and partial RM², LACM 130827.

LOCALITY. LACM 5616.

FAUNA AND AGE. Brea Canyon Local Fauna, late Uintan.

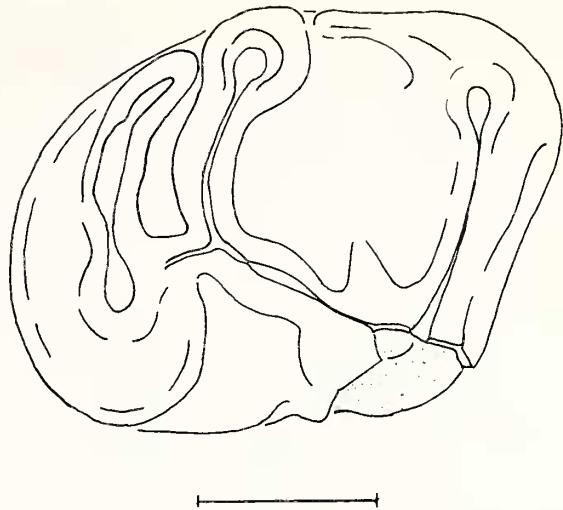


Figure 13. *Leptotomus* sp. undet., LM₃, LACM 131465, occlusal view. Scale = 1 mm.

DISCUSSION. Kelly et al. (1991) questionably assigned LACM 130827 to an undetermined dichobunid. Further preparation and examination of this specimen indicates that it is referable to *Eohaplomys matutinus*. The measurements of the RM¹ of LACM 130827 are 4.21 mm A-P and 4.88 mm TR.

Superfamily Geomyoidea Weber, 1904

Family ?Geomyidae Gill, 1872

Genus *Griphomys* Wilson, 1940b

Griphomys alecer Wilson, 1940b

Figure 15, Tables 5 and 6

REFERRED SPECIMENS. In addition to those referred elsewhere (Lillegraven, 1977); 2?RdP⁴s, LACM 130801, 132427; 2?LdP⁴s, LACM 130776, 132428; partial left maxilla with P⁴ and partial M¹, LACM(CIT) 2525; LP⁴, LACM 132432; 2RM¹s, LACM 130777, LACM(CIT) 2526; LM¹, LACM 130781; 3RM²s, LACM 130778, 132425, 132429; 2LM²s, LACM 130779, 132431; LM³, LACM 132462; holotype, partial right dentary with P₄–M₂, LACM(CIT) 2522; partial right dentary with P₄ and M₂, LACM(CIT) 2524; 3RP₄s, LACM 130782, 130784, 130789; 2LP₄s, LACM 130783, 133993;

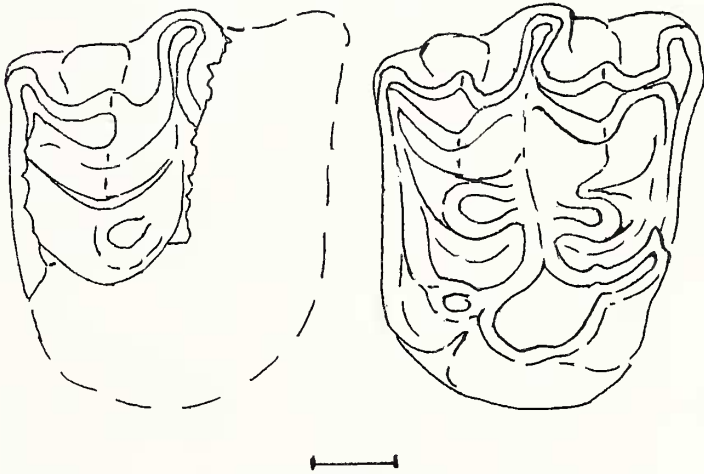


Figure 14. *Eohaplomys matutinus* Stock, RM¹ and partial RM², LACM 130827, occlusal views. Scale = 1 mm.

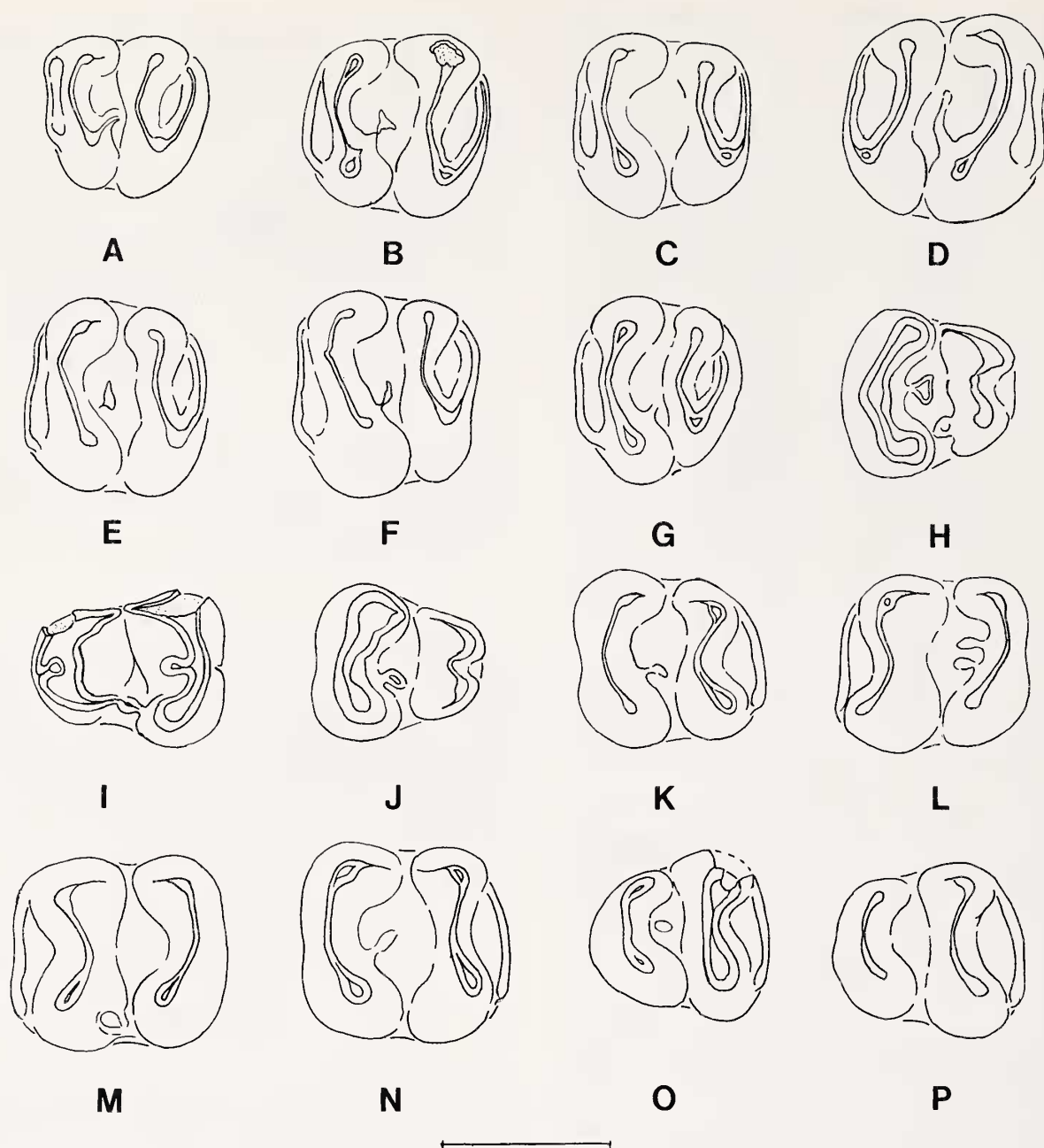


Figure 15. *Griphomys alecer* Wilson, A. RdP¹, LACM 132428; B. LP¹, LACM 132432; C. LM¹, LACM 130781; D. RM², LACM 130778; E. LM², LACM 130779; F. LM², LACM 132431; G. LM³, 132462; H. RP₄, LACM 130782; I. LP₄, LACM 130783; J. RP₄, LACM 130784; K. RM₁, LACM 130785; L. LM₂, LACM 130774; M. LM₂, LACM 130775; N. RM₂, LACM 130780; O. RM₃, LACM 130787; P. RM₃, LACM 130790. All occlusal views. Scale = 1 mm.

RM₁, LACM 130785; 2LM_{1s}, LACM 130788, 132470; partial right dentary with M₂, LACM(CIT) 2523; 4LM_{2s}, LACM 130774, 130775, 132424, 132426; 2RM_{2s}, LACM 130780, 132430; 3RM_{3s}, LACM 130786, 130787, 130790; LM₃, UCMP 79479.

LOCALITIES. Sespe Formation, LACM(CIT) 150, 202, 207, LACM 5612, 5616, 5661, 5855, 5857, 5859, 5860, 5866, 5868, 5869; ?Santiago Formation, UCMP V-72088.

FAUNAS AND AGE. Tapo Canyon, Brea Canyon, and Pearson Ranch Local Faunas, Simi Valley, and Camp San Onofre Local Fauna, Camp Pendleton Marine Corps Base, California; late Uintan to early Duchesnean.

DESCRIPTION. Four teeth (LACM 130776, 130801, 132427, 132428), tentatively assigned to dP⁴s, were recovered during the program from localities LACM 5616, 5661, and 5860. These teeth are morphologically very similar to the permanent upper cheek teeth except for being slightly smaller and relatively narrower transversely, and by having

the anterior cingulum usually not extending as far lingually.

The permanent cheek teeth of *Griphomys alecer* have been well described by Wilson (1940b), Lindsay (1968), and Lillegraven (1977). However, due to the small number of teeth in the original samples of *G. alecer*, additional details on intraspecific variation are described below.

All of the upper molars have the central transverse valleys open labially and lingually, and all are lacking a preprotocrista. However, one upper molar has a very small mesostyle present between the paracone and metacone, but this cusp is not high enough to block the labial opening of the central transverse valley. A small anterocone is usually present as a small cusp along and near the lingual termination of the anterior cingulum. The most variable character of the upper molars is the development of a protoloph spur, which usually comprises a small crest that originates along the posterior face of the protoloph near its connection with the protocone and extends posteriorly into

Table 5. Measurements (in mm) of upper dentition of *Griphomys alecer*.

N	Tooth/ dimension	O.R.	Mean	S.D.	C.V.
4	dP ⁴ A-P	0.96-1.04	1.03		
4	ANT-TR	0.85-1.05	0.96		
4	POST-TR	0.83-1.05	0.94		
2	P ⁴ A-P	1.14-1.22	1.18		
2	ANT-TR	1.08-1.21	1.15		
2	POST-TR	1.12-1.16	1.14		
4	M ¹ A-P	1.12-1.30	1.20		
3	ANT-TR	1.19-1.26	1.24		
3	POST-TR	1.15-1.30	1.20		
8	M ² A-P	1.11-1.24	1.17	0.05	4.2
8	ANT-TR	1.19-1.42	1.27	0.08	6.0
8	POST-TR	1.13-1.28	1.17	0.05	4.3
2	M ³ A-P	1.01-1.05	1.03		
2	ANT-TR	1.17-1.18	1.175		
2	POST-TR	1.04-1.10	1.07		

the central transverse valley of the tooth where it then turns labiad for a short distance. Lillegraven (1977) identified this structure as a low posterior protocrista. Whether this structure is homologous with a postprotocrista or an anterior ectoloph (= anterior mure) and a vestigial mesoloph is uncertain. Nevertheless, the following variations of this spur are exhibited by the Simi Valley upper molars of *G. alecer*: (1) the spur is completely lacking; (2) the spur is very small and only extends a very short distance posterolabially where it terminates at the posterior base of the protocone and does not extend into the central transverse valley; (3) the spur extends posterolabially from the protoloph about midway into the central transverse valley and resembles a vestigial mesoloph; and (4) the spur forms a small cristid that originates at the base of the protoloph, just labial to its connection with the protocone, and then extends posterolabially in a curved fashion into the central transverse valley resembling a small mesoloph. No distinct cusps or swellings are exhibited on any of the spurs that could be regarded as mesocones.

In the P₄ the most variable character is the development of the ectolophid and its associated mesoconid. Mesoconids, which may be represented by a distinct isolated cusp in the central transverse valley or by a distinct swelling at the middle of the ectoloph, are usually present. The mesoconid-ectolophid structure varies in the Simi Valley P₄s as follows: (1) ectolophid incomplete, mesoconid absent, ectolophid represented by a small cristid or loph that projects anteriorly from the hypolophid into the middle of the central transverse valley and terminates about halfway across this valley; (2) ectolophid complete, mesoconid absent, ectolophid represented by a small cristid that projects anteriorly from the hypolophid across the transverse central valley and connects with the metalophid; (3)

Table 6. Measurements (in mm) of lower dentition of *Griphomys alecer*.

N	Tooth/ dimension	O.R.	Mean	S.D.	C.V.
7	P ₄ A-P	0.96-1.14	1.08	0.07	6.0
6	ANT-TR	0.71-0.83	0.77	0.04	5.5
6	POST-TR	0.91-1.05	0.99	0.05	5.3
4	M ₁ A-P	1.13-1.19	1.16		
4	ANT-TR	0.91-1.04	0.98		
4	POST-TR	0.97-1.19	1.05		
11	M ₂ A-P	1.18-1.35	1.23	0.05	4.2
11	ANT-TR	0.97-1.25	1.14	0.08	6.9
11	POST-TR	1.00-1.23	1.13	0.07	6.2
4	M ₃ A-P	1.07-1.23	1.15		
4	ANT-TR	0.98-1.07	1.01		
4	POST-TR	0.86-0.90	0.88		

ectolophid complete, mesoconid present, ectolophid represented by a complete cristid extending anteriorly from the hypolophid across the central transverse valley where it is connected with the metalophid, and the mesoconid is a distinct bulge or swelling midway along the cristid; and (4) ectolophid absent, but an isolated well-developed, triangular-shaped mesoconid is present with one apex of the triangle connected to the middle of the anterior face of the hypolophid. The central transverse valley is usually open labially; however, in two premolars a slight bulge, which may represent a vestigial ectostylid, is present midway along a weakly developed cristid at the labial aspect of the tooth between the protoconid and the hypoconid. This bulge does not represent a mesoconid because in both of these premolars a mesoconid is present in the central transverse valley.

The lower molars vary in the development of cristids and cusps in the central transverse valleys as follows: (1) cusps or cristids absent; (2) a distinct isolated cusp or mesoconid in the central transverse valley with cristids absent; and (3) an incomplete ectolophid, which may be a distinct cristid or very low indistinct cristid that originates on the anterior face of the hypolophid, lingual to the hypoconid, and extends midway anterolingually or anteriorly into the central transverse valley. In the teeth exhibiting an incomplete ectolophid, a distinct mesoconid usually cannot be differentiated from the ectolophid. In one tooth (LACM 130774), two cristids originate on the anterior face of the hypolophid and extend anteriorly into the central transverse valley. The most labial cristid appears to represent a partial ectolophid with a small cusp or mesoconid at its termination. The lingual cristid does not exhibit a cusp, and this cristid may be a duplication of the ectolophid. Another lower molar (LACM 130775) is also distinctive in that it exhibits a small bulge or cuspule (= ?ectostylid) at the posterolabial base of the protoconid and a thin low cristid (= ?labial cingulid) that extends posteriorly from this

cuspsule to join with the anterolabial base of the hypoconid.

DISCUSSION. Many investigators have discussed the taxonomic relations of *Griphomys* even though the fossil record of this genus was previously very sparse (Wilson, 1940b, 1949; Lindsay, 1968; Emry, 1972; Wood, 1974; Sutton and Black, 1975; Lillegraven, 1977; Black and Sutton, 1984). Wilson (1940b) described *Griphomys alecer* and *G. sp.*, near *alecer* on the basis of five specimens representing a total of nine teeth from the Sespe Formation of Simi Valley. Lillegraven (1977) assigned six specimens representing a total of six teeth from the Camp San Onofre Local Fauna, ?Santiago Formation, Camp Pendleton Marine Corps Base, California, to *G. alecer*. Lillegraven (1977) also assigned four isolated teeth from the ?Santiago Formation to a second species of *Griphomys*, *G. toltecus*. Lindsay (1968) referred an LM₃ from the Hartman Ranch Local Fauna of the Sespe Formation, north of the town of Ojai, California, to an undetermined species of *Griphomys*. Golz and Lillegraven (1977) reported the occurrence of *Griphomys sp.* from the Laguna Riviera Local Fauna, ?Santiago Formation, Oceanside area, California. Sutton and Black (1975) questionably assigned an RM₃ from the Pilgrim Creek Local Fauna, Colter Formation, Jackson Hole, Wyoming, to *Griphomys*. Mary R. Dawson (pers. commun. in Sutton and Black, 1975) reported that *Griphomys* may occur in the Badwater faunas from the ?Wagon Bed Formation of Wyoming. The above records represent the entire previously known occurrences of *Griphomys* in the fossil record. Most investigators regard *G. sp.*, near *alecer* to be synonymous with *G. alecer*, although none have presented new evidence to support this assumption (Lillegraven, 1977; Black and Sutton, 1984; Kelly, 1990; Kelly et al., 1991).

The impact mitigation program at the Simi Valley Landfill has resulted in the recovery of 30 additional teeth of *G. alecer* from 11 different stratigraphic levels in the Sespe Formation. The LM₃ described by Lindsay (1968) from the Hartman Ranch Local Fauna can now be confidently assigned *G. alecer* because it is indistinguishable from the newly discovered M₃s of this species from Simi Valley. A total of 46 teeth are now assigned to *G. alecer*.

The four teeth identified herein as deciduous P⁴s are only tentatively assigned to *G. alecer*. These teeth could represent a different species of *Griphomys* because they are smaller than the permanent P⁴s of *G. alecer*. However, these teeth were recovered from three different localities that each yielded other teeth that were definitely assignable to *G. alecer*. Furthermore, these teeth are almost identical in structure to the other upper cheek teeth assigned to *G. alecer*, including the presence of small protoloph spurs and strongly bilophodont occlusal patterns.

The larger sample of *G. alecer* teeth allows for reevaluation of intraspecific variation and morphological change through time. Wilson (1940b) divid-

ed the specimens of *Griphomys* into three taxa: *G. alecer* from locality LACM(CIT) 207, *G. sp.*, near *alecer* from locality LACM(CIT) 202, and *G. sp.*, near *alecer* from locality LACM(CIT) 150. These taxa were separated on the basis of the following characters: (1) slight differences in tooth size; (2) slight differences in the occlusal outlines of the P₄s; (3) the presence or absence of vestigial mesoconids on the lower cheek teeth; (4) slight differences in the widths of the lower molar trigonids; and (5) the different stratigraphic occurrences of each taxon. Wilson noted that the teeth of *Griphomys* from localities LACM(CIT) 202 and 207 were extremely similar and, considering the amount of individual variation present in other Eocene rodents, were probably conspecific. Wilson considered the sample of *Griphomys* from locality LACM(CIT) 150 most likely to represent a different species because the lower cheek teeth lack vestigial mesoconids, whereas those of *G. alecer* and *G. sp.*, near *alecer* from localities LACM(CIT) 202 and 207 possess vestigial mesoconids. The development of protoloph spurs and mesoconids on the teeth of *Griphomys* does appear to vary somewhat depending upon the stratigraphic level from which they were collected. In ascending stratigraphic order, these variations are as follows: (1) from the level of locality LACM 5855 to that of locality LACM(CIT) 207, all upper cheek teeth have protoloph spurs and all lower cheek teeth have mesoconids present; (2) from the level of locality LACM(CIT) 202 to that of locality LACM 5866, the presence of protoloph spurs on the upper molars and mesoconids in the lower cheek teeth is highly variable; and (3) from the level of locality LACM (CIT) 150, all upper and lower cheek teeth lack protoloph spurs and mesoconids, respectively. Although there is an increase in the loss of protoloph spurs and mesoconids with decreasing geologic age, the cheek teeth that lack protoloph spurs and mesoconids from low in the section are otherwise indistinguishable from those of *G. sp.*, near *alecer* from locality LACM(CIT) 150. Furthermore, the new teeth recovered during the impact mitigation program at the Simi Valley Landfill and those described by Lillegraven (1977) confirm that all of the characters that Wilson (1940b) used to separate species of *Griphomys* are highly variable and not reliable for species identification. Therefore, all the specimens from the Sespe Formation of Simi Valley and those referred to *G. alecer* by Lillegraven (1977) from the ?Santiago Formation can confidently be assigned to *G. alecer*.

Griphomys is generally regarded as belonging to the superfamily Geomyoidea and questionably assigned to the Geomyidae because of the bilophodont structure of the molars (Wilson, 1940b, 1949; Lindsay, 1968; Sutton and Black, 1975; Wood, 1974; Black and Sutton, 1984). Wilson (1949) suggested that *Griphomys* may have been derived from an ancestral sciuravine similar to the Bridgerian *Taxymys* Marsh, 1872. Lillegraven (1977) speculated that *Griphomys* may be derived from a "*Nama-*

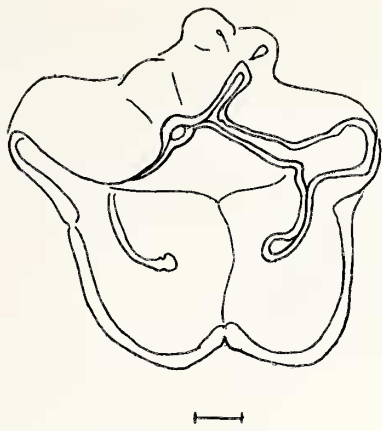


Figure 16. ?Isectalophid, gen and sp. undet., right upper cheek tooth, LACM 133987, occlusal view. Scale = 1 mm.

tomys fantasma”-like eomyid based on his interpretation of the origin of the transverse lophids in *Griphomys*. “*Namatomys*” is a distinct genus of early eomyid rodents that differs from *Namatomys* Black, 1965 (Chiment, 1977; Lillegraven, 1977; Storer, 1987; Kelly, 1992) and will be assigned to a new genus in a forthcoming report by J.J. Chiment and W.W. Korth (pers. commun., 1992). Storer (1987) considered “*Namatomys*” to be derived from a sciuravid resembling the Wasatchian *Knightomys* Gazin, 1961 (Wood, 1965; Korth, 1984).

Taxymys is a poorly known taxon and only the upper dentition is confidently assigned to this genus (Marsh, 1872; Wilson, 1938; Bown, 1982). The upper molars of *Griphomys* resemble those of *Taxymys* in their bilophodont structure. The major changes in the upper cheek teeth that would be required to derive *Griphomys* from a *Taxymys*-like sciuravine are as follows: (1) loss of the P³; (2) development of a hypocone and metaloph on the P⁴ with subsequent widening of the central transverse valley and molarization; and (3) in the upper molars, loss of the metaconules on the metalophs, development of the protoloph spurs, and extreme reduction or loss of the mesostylids. The major changes in the teeth that would be required to derive *Griphomys* from a “*Namatomys fantasma*”-like eomyid ancestor are as follows: (1) loss of the crests extending from the anterocone and anteroconid to the protoloph and metalophid, respectively; (2) loss of the posterior portion of the ectoloph and ectolophid; and (3) a slight increase in the height and development of the main loph and lophids (protoloph, metaloph, metalophid, and hypolophid) resulting in greater bilophodonty. The development of the ectoloph, ectolophid, and the crests and cristids extending from the anterocone and anteroconid to the protoloph and metalophid, respectively, are derived characters for “*Namatomys*” (Chiment, 1977) and would not be expected in a basal eomyid ancestor. It appears that *Griphomys* is more easily derived from an ancestral eomyid-like form, as suggested by Lillegraven (1977), than from a *Taxymys*-like sciuravid. Storer (1987) presented convincing evidence for the derivation of

the early Uintan to late Duchesnean “*Namatomys*” from an ancestral sciuravid resembling the Wasatchian *Knightomys*. It is possible that *Griphomys* was derived from an ancestral “*Namatomys*”-like eomyid during the intervening Bridgerian, making *Griphomys* a sister taxon of the eomyids. However, all of the above proposed evolutionary relationships are highly speculative. Details of the cranial and postcranial morphology of *Griphomys*, which would further clarify the phylogeny of the genus, are unfortunately unknown. Nevertheless, *Griphomys* is a distinctive taxon that exhibits affinities with both the Eomyidae and the Geomyoidea.

Order Perissodactyla Owen, 1848

Family Isectolophidae Peterson, 1919

?Isectolophid, gen. and sp. undet.
Figure 16

REFERRED SPECIMEN. Right upper cheek tooth, LACM 133987.

LOCALITY. LACM 5616.

FAUNA AND AGE. Brea Canyon Local Fauna, late Uintan.

DESCRIPTION. The position of the upper cheek tooth from locality LACM 5616 within the dental arcade is uncertain; it could be a deciduous P⁴ or a molar. The parastyle is a distinct cusp that is connected to the ectoloph and the protoloph. The labially positioned paracone is a robust bilobed cusp. The metacone is the tallest and most prominent cusp along the ectoloph. A small metacone rib is present. The posterior crest of the metacone extends posteriorly as a broadly curved crest and joins with the small metastyle. The anterior crest of the metacone extends anteriorly a very short distance where it then bifurcates into two crests, one leading anterolabially to join with the paracone and the other extending anteriorly to join with the parastyle. The protocone and hypocone are prominent cusps separated by a central transverse valley that extends from the ectoloph to the lingual aspect of the tooth. The protoloph is a gently curved crest that extends from the protocone to join with the parastyle. The metaloph is slightly less prominent than the protoloph and extends labially from the hypocone to join with the base of the ectoloph at a point about midway between the metacone and the metastyle. The anterior, lingual, and posterior cingulae are well developed, whereas a labial cingulum is lacking. The measurements of LACM 133987 are 7.5 mm A-P and 7.6 mm TR.

DISCUSSION. Kelly et al. (1991) questionably assigned the upper cheek tooth from locality LACM 5616 to an isectolophid perissodactyl, genus and species undetermined. This tooth exhibits characters that are similar to those of the Isectolophidae, including a prominent ectoloph with a well-developed parastyle and paracone, a reduced metastyle, and a cross lophed occlusal pattern formed by the

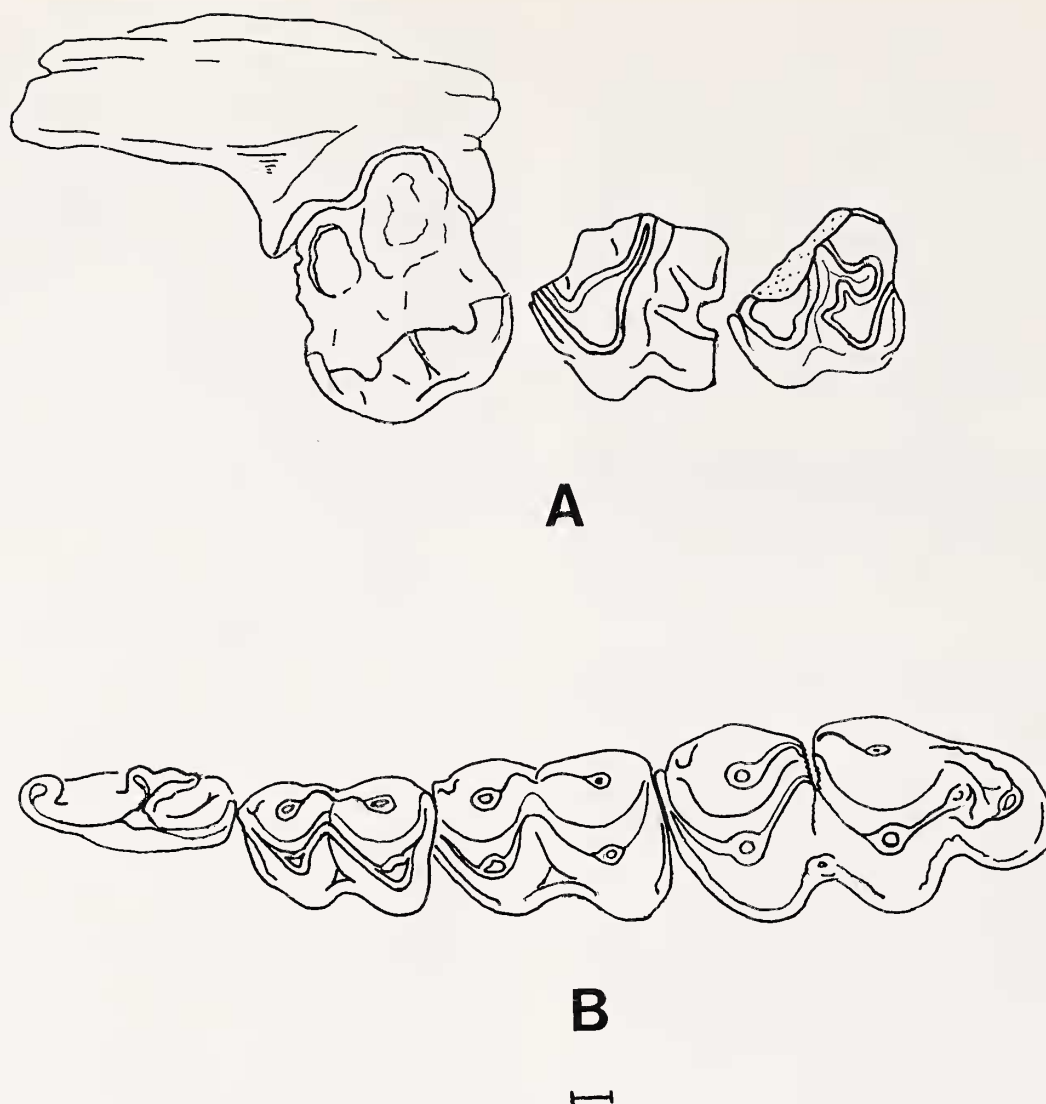


Figure 17. *Protylepus robustus* Golz, A. partial RM¹⁻³, LACM 131448; B. LP₄-M₃, LACM 131447. All occlusal views. Scale = 1 mm.

protoloph and metaloph. However, the tooth is very distinctive and does not compare well with those of any previously described genus or species of isectolophid (Radinsky, 1963; Schoch, 1989). This tooth could represent a previously unrecognized deciduous premolar or a developmental anomaly of a known isectolophid. Until a better sample of this taxon is available and following Kelly et al. (1991), this tooth is very questionably assigned to the Isectolophidae.

Order Artiodactyla Owen, 1848

Family Oromerycidae Gazin, 1955

Genus *Protylepus* Wortman, 1898

Protylepus robustus Golz, 1976

Figure 17, Table 7

REFERRED SPECIMENS. Partial right maxilla with broken M¹⁻³, LACM 131448; partial left dentary with P₄-M₃, LACM 131447.

LOCALITY. LACM 5616.

FAUNA AND AGE. Brea Canyon Local Fauna, late Uintan.

DISCUSSION. Golz (1976) described the rare oromerycid *Protylepus robustus* on the basis of two partial dentaries, the holotype (UCR 12833)

from the Laguna Riviera Local Fauna of the ?Santiago Formation, Carlsbad area, California, and a referred specimen (LACM 26363) from the Brea Canyon Local Fauna of the Sespe Formation of Simi Valley. The holotype is well worn, and the referred specimen from the Sespe Formation is a poorly preserved partial left dentary with the M₂ and a broken M₃. The impact mitigation program at the Simi Valley Landfill has resulted in the discovery of the first upper molars of *P. robustus* and a well-preserved, slightly worn partial left dentary with P₄-M₃ (Kelly et al., 1991).

The upper molars of LACM 131448 are damaged with the M¹ represented by the protocone and a partial paracone and metaconule, the M² represented by a partial protocone and the metaconule, and the M³ represented by a partial protocone and metaconule. These molars exhibit the following characters: (1) crescentic labial cusps; (2) bifurcated postprotocristae; (3) moderately developed anterior and posterior cingulae; and (4) labial shelves between the protocones and metaconules.

The lower molars of *P. robustus* have been well described by Golz (1976). However, the teeth of the newly discovered dentary are less worn than those of the holotype and exhibit the following differences: (1) the P₄ metaconid is slightly more developed; (2) the metaconid in the lower molars

Table 7. Measurements (in mm) of teeth of *Protylopus robustus*.

Tooth/ dimension	LACM 131449	LACM 131448
M ¹ A-P	—	
TR	8.6 (estimated)	
M ² A-P	—	
TR	—	
M ³ A-P	11.5 (estimated)	
TR	10.6 (estimated)	
P ₄ A-P		8.1
TR		4.2
M ₁ A-P		8.1
TR		6.4
M ₂ A-P		9.5
TR		7.5
M ₃ A-P		16.6
TR		8.3
M ₁ –M ₃		34.3

is not connected to the co-joined cristids from the protoconid and hypoconid; and (3) the M₃ hypoconulid basin has a small cuspile at the anterior labial corner near the termination of the posterior cristid of the metaconid.

Family Camelidae Gray, 1821

?Camelidae, gen. and sp. undet.
Figure 18

REFERRED SPECIMEN. Partial RM², LACM 130828.

LOCALITY. LACM 5876.

FAUNA AND AGE. Simi Valley Landfill Local Fauna, late Duchesnean.

DESCRIPTION. The only specimen referable to this taxon is a well-worn, partial RM² that is missing the mesostylar region, the paracone, the anterolabial portion of the preprotocrista, and part of the anterior cingulum. The tooth appears to have been transversely elongated with a rectangular occlusal outline. The partial ectoloph, which extends from the metastyle to the anterior aspect of the metacone, is relatively straight. The metastyle is very small and the rib on the labial surface of the metacone is weakly developed. The protocone is deeply worn. The partial preprotocrista extends anterolabially and, presumably, was connected with the missing parastyle. The postprotocrista is rounded with wear and is separated from the anterior crest of the metaconule by a narrow valley between the protocone and metaconule. The anterior crest of the metaconule extends anterolabially wherein it joins the posterior crest of the paracone and the anterior crest of the metacone. The posterior crest of the metaconule extends posterolabially and joins with the metastyle and the posterior crest of the metacone. The metacone and metaconule are crescentic and, even in their worn state, exhibit a mod-

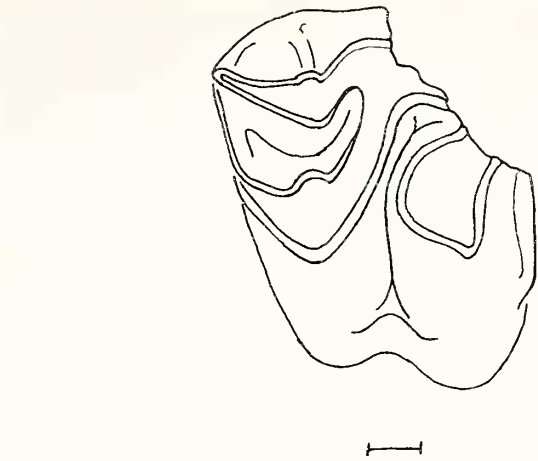


Figure 18. ?Camelidae, gen. and sp. undet., partial RM², LACM 130828, occlusal view. Scale = 1 mm.

erate degree of selenodonty. The anterior cingulum is moderately well developed and a small lingual cingulum is present between the protocone and metaconule, whereas labial and posterior cingulae are lacking. The measurements of LACM 130828 are as follows: 5.0 mm (estimated) A-P, 7.6 mm (estimated) ANT-TR, and 6.6 mm POST-TR.

DISCUSSION. The partial M² from Simi Valley differs from those of other middle to late Eocene selenodont artiodactyls, including *Protoreodon* Scott and Osborn, 1887, *Diplobunops* Peterson, 1919, *Protylopus* Wortman, 1898, *Oromeryx* Marsh, 1894, *Eotylopus* Matthew, 1910, *Malaquiferous* Gazin, 1955, *Camelodon* Granger, 1910, *Leptoreodon* Wortman, 1898, *Leptotragulus* Scott and Osborn, 1887, *Poabromylus* Peterson, 1931, *Hendryomeryx* Black, 1978, *Simimeryx* Stock, 1934c, and *Leptomeryx* Leidy, 1853, by having a much less developed metastyle and an apparently straighter ectoloph. It further differs from those of species of the Oromerycidae by lacking a bifurcated postprotocrista and having a weaker developed rib on the metacone.

The Simi Valley tooth is most similar to those of *Poebrodon kayi* Gazin, 1955, from the Uinta Formation of Utah. These similarities include a relatively straight ectoloph, a very small metastyle, a weakly developed rib on the metacone, a crescentic metaconule, and a tendency for the anterior crest of the metaconule to join with the posterior crest

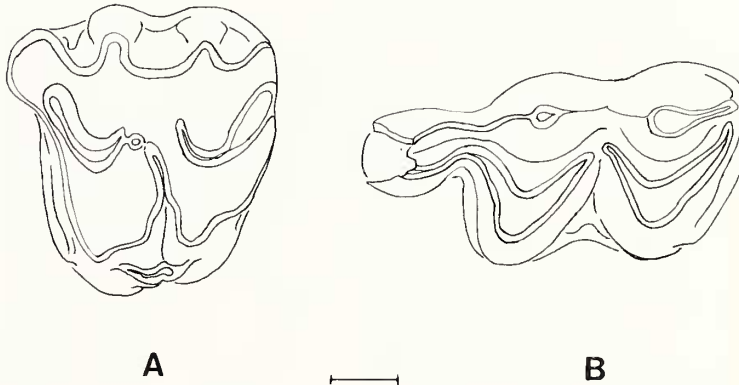


Figure 19. *Simimeryx* sp., aff. *S. hudsoni* Stock, A. RM², LACM 130869; B. RM₁, LACM 130868. All occlusal views. Scale = 1 mm.

of the paracone with wear. The missing paracone, parastyle, and mesostyle in the Simi Valley tooth do not allow a comprehensive comparison with species of *Poebrodon*. However, it differs from those of *Poebrodon* by being more transversely expanded and having greater development of the anterior and labial cingulae.

The Simi Valley tooth appears to belong to a taxon that is most closely related to the middle Eocene *Poebrodon*, but, because of the incomplete nature of the Simi Valley specimen, it is herein questionably referred to the Camelidae.

Family Hypertragulidae Cope, 1879

Genus *Simimeryx* Stock, 1934c

Simimeryx sp., aff. *S. hudsoni* Stock, 1934c

Figure 19

Simimeryx n. sp. Kelly et al., 1991:8.

REFERRED SPECIMENS. Partial RM¹ and partial RM², LACM 130867; RM², LACM 130869; RM₃, LACM 130868.

LOCALITY. LACM 5876.

FAUNA AND AGE. Simi Valley Landfill Local Fauna, late Duchesnean.

DESCRIPTION. The upper molars of *Simimeryx* sp., aff. *S. hudsoni* are represented by a partial M¹ that is missing the paracone and protocone, a partial M² that is missing the ectoloph, and a complete M². The paracone is a rounded conical cusp. The parastyle is robust and positioned at the anterolabial corner of the tooth. The metaconules are well developed and crescentic. The posterior crest of the metaconule extends anterolabially where it joins the posterior cingulum. The anterior crest of the metaconule extends posterolabially to the anterolabial base of the paracone where it turns lingually towards the posterior crest of the protocone. The labial cingulum is reduced on the upper molars so that it is distinct anteriorly, posteriorly, and between the paracone and metacone, but barely discernable along the labial surfaces of the paracone and metacone. The anterior and lingual cingulae are moderately well developed, but the posterior cingulum varies from a moderately distinct crest to absent. The measurements of the only complete upper molar are 5.6 mm A-P, 6.6 mm ANT-TR, and 6.0 mm POST-TR.

The M₃ is anteroposteriorly elongated and moderately well worn. The paraconid and entoconid are conical and somewhat bunodont cusps, whereas the protoconid and metaconid are crescentic. The parastylid is a distinct cristid that extends labially from the termination of the preprotocristid wherein it turns posteriorly to join the mediolabial surface of the paraconid. The anterior and lingual cingulids are moderately developed. A robust hypoconulid is present. The measurements of the M₃ are 8.8 mm A-P and 4.7 mm TR.

DISCUSSION. The teeth from locality LACM 5876 are referred to *Simimeryx* because the upper

molars lack mesostyles and have robust parastyles, postprotocristae that are posterolabially directed, and lingual cingulae. Also, the morphology of the M₃ hypoconulid is more like those of *Simimeryx* than those of other hypertragulids.

Two species of *Simimeryx* are currently recognized: *S. hudsoni* of the Pearson Ranch Local Fauna, Sespe Formation, California, and *S. minutus* Peterson, 1931, of the Lapoint Fauna, Duchesne River Formation, Utah. Fossils of *Simimeryx hudsoni* are well represented in the collections from the Sespe Formation, whereas *S. minutus* is known only from fragmentary material. The samples of *Simimeryx* teeth from locality LACM 5876 differ from those of *S. hudsoni* by having the following characters: (1) the teeth are slightly larger and slightly more selenodont; (2) the parastyle and parastylid are more labially positioned and the parastyle is slightly more reduced; (3) the anterior crest of the metaconule extends further posterolabially to the anterolabial base of the paracone where it turns lingually towards the posterior crest of the protocone; (4) the upper molar anterior, posterior, and lingual cingulae are less developed; (5) the upper molar labial cingulum is much less developed; and (6) the M₃ hypoconulid is proportionately larger. It is difficult to compare the *Simimeryx* teeth from locality LACM 5876 with those of *S. minutus* because of the lack of comparative material, but the measurements of the Simi Valley teeth are much larger. The teeth from locality LACM 5876 are more derived than those of *S. hudsoni*, as indicated by their greater selenodonty, slightly more reduced cingulae and reduced parastyles in the upper molars, and relatively larger M₃ hypoconulid, and appear to represent a new species. However, until an adequate sample of this taxon is available, these teeth are assigned to *S. sp.*, aff. *S. hudsoni*.

Most investigators regard *Simimeryx* as a member of the Hypertragulidae (Stock, 1934c; Gazin, 1955; Golz, 1976). However, Emry (1978) hesitated to include *Simimeryx* in this family because *Simimeryx* differs from the more typical hypertragulids, *Hypertragulus* Cope, 1873, and *Parvitrágulus* Emry, 1978, by having (1) the protocones and metaconules of the upper molars in different positions relative to *Simimeryx* and (2) a very distinctive M₃ hypoconulid morphology. The teeth of *S. sp.*, aff. *S. hudsoni* exhibit some similarities with those of *Parvitrágulus* and *Hypertragulus*, such as the reduced molar cingulae and cingulids. The M₃ hypoconulid of *S. sp.*, aff. *S. hudsoni* is also proportionally larger than those of *S. hudsoni* and possesses a deeper central basin that is intermediate to those of *S. hudsoni* and those of other hypertragulids. The teeth of *S. sp.*, aff. *S. hudsoni* differ from those of *Parvitrágulus* and *Hypertragulus* by having the following characters: (1) larger and less hypsodont molars; (2) less transversely compressed upper molars; (3) much less developed paracone and metacone ribs; (4) a greatly reduced metastyle; (5) a more posteriorly directed postprotocrista; and (6) a rel-

atively smaller M₃ hypoconulid. The teeth of *S. sp.*, aff. *S. hudsoni* appear to be morphologically intermediate to those of *S. hudsoni* and those of the more typical hypertragulids, suggesting, contrary to Emry (1978), that *Simimeryx* should be included with the Hypertragulidae.

Mammalia
gen. and sp. undet.
Figure 20

REFERRED SPECIMEN. Partial right upper cheek tooth, LACM 130865.

LOCALITY. LACM 5876.

FAUNA AND AGE. Simi Valley Landfill Local Fauna, late Duchesnean.

DESCRIPTION. The partial tooth (LACM 130865) is missing part of the metaconule and posterior cingulum, and the metacone. The occlusal outline appears to have been subtriangular in shape. A small metastyle is present. The protocone and metacone are tall conical cusps, with the protocone larger than the metacone. The protocone exhibits a postprotoconular fold that extends posterolabially towards the posterior cingulum and a very vestigial postprotocrista that extends between the protocone and the metaconule. The preprotocrista is a complete crest forming a protoloph that extends anterolabially from the protocone to join with the protoconule. The protoconule exhibits an oval wear pattern and appears to be smaller than the metaconule. Only about half the metaconule is present, and it also appears to have had an oval wear pattern. The anterior cingulum is robust and extends lingually from the metastyle to about half way along the anterior face of the protocone. The labial cingulum is moderately developed across the labial surface of the metacone. A small distinct cusp (= ?pericone) is present along the anterior cingulum near its lingual termination. The partial posterior cingulum is robust and a small cusp (= ?hypocone) is present near its lingual termination. The measurements of LACM 130865 can only be estimated as follows: 3.7 mm A-P and 4.6 mm TR.

DISCUSSION. The partial upper cheek tooth (LACM 130865) from Simi Valley is perplexing because its ordinal and familial assignment is uncertain. Kelly et al. (1991) assigned this tooth to an undetermined omomyine primate based on the presence of a postprotoconular fold. Further preparation and examination of this specimen makes this assignment questionable. Because of the incomplete nature of the specimen, it is herein assigned to Mammalia, gen. and sp. undet.

CONCLUSIONS

The paleontologic resource impact mitigation program at the Simi Valley Landfill has yielded large samples of superposed middle to late Eocene small mammal assemblages. New taxa and additional specimens of poorly known taxa were recovered



Figure 20. Mammalia, gen. and sp. undet., partial right upper cheek tooth, LACM 130865, occlusal view. Scale = 1 mm.

during the program. Prior to this report, many of these taxa were inadequately described because they were represented by fragmentary specimens or very small samples.

The discovery of the following Uintan taxa from the middle member of the Sespe Formation is documented: *Centetodon* sp., cf. *C. aztecus*; erinaceomorph, gen. and sp. undet.; *Uintasorex* sp., cf. *U. montezumicus*; *Microparamys woodi* n. sp.; *Microparamys* sp., cf. *M. tricus*; *Miacis* sp. undet.; and ?isctolophid, gen. and sp. undet. Also, the discovery of the following Duchesnean taxa from the middle member of the Sespe Formation is documented: *Peradectes californicus*; *Leptotomus* sp. undet.; ?Camelidae, gen. and sp. undet.; *Simimeryx* sp., aff. *S. hudsoni*; and Mammalia, gen. and sp. undet.

The impact mitigation program at the Simi Valley Landfill has resulted in larger samples of the teeth of the primate *Dyseolemur pacificus*, the rodent *Griphomys alecer*, and the artiodactyl *Protylopus robustus*. The new specimens of *D. pacificus* described herein include the first P⁴ and the third M³ of this species recovered from the Sespe Formation. Among the known teeth of *D. pacificus*, the M³ appears to exhibit the greatest variation in morphology. In the teeth of *G. alecer*, the most variable characters are the development of the upper molar protoloph spurs and the lower molar mesoconids. The teeth of *G. alecer* exhibit similarities with those of the Eomyidae and the Geomyidae, and *Griphomys* may have originated from a “*Namatomys*”-like eomyid ancestor. The new specimens of *P. robustus* described herein include the first upper molars referable to this species and a well-preserved partial left dentary with P₄–M₃.

Centetodon sp., cf. *C. aztecus* and *Microparamys woodi* are now known to have a geologic range from the early late Uintan Tapo Canyon Local Fauna to the late Uintan Brea Canyon Local Fauna. *Sespedectes singularis* is now recorded in the Simi Valley Landfill Local Fauna, and this occurrence extends the geologic range of this species upward into the late Duchesnean.

The taxa that constitute the late Duchesnean Simi Valley Landfill Local Fauna from locality LACM 5876 (Kelly et al., 1991; Kelly, 1992) can now be revised to include the following: *Peradectes californicus*; *Sespedectes singularis*; *Leptotomus* sp. undet.; “*Namatomys*” sp.; *Paradjidaumo reynoldsi* Kelly, 1992; *Heliscomys* sp.; *Simiarcitomys whistleri* Kelly, 1992; *Simimys simplex* (Wilson, 1935); *Simimys landeri* Kelly, 1992; *Simimeryx* sp., aff. *S. hudsoni*; ?Camelidae, gen. and sp. undet.; and Mammalia, gen. and sp. undet. Although the taxa that constitute the Simi Valley Landfill Local Fauna do not modify the extensive ecological interpretations of the paleoenvironment of the Sespe Formation presented by other investigators (Stock, 1932; Taylor, 1983, 1984; Krishtalka et al., 1987; Mason, 1988; Kelly, 1990), they do add knowledge to the characterization of the Duchesnean Land Mammal Age. The Duchesnean was previously characterized by the first appearances of *Leptictis*, *Protadjidaumo*, *Ischyromys*, *Pseudocylindrodon*, *Ardynomys*, *Jaywilsonomys*, *Presbymys*, *Eutypomys*, *Adjidaumo*, *Aulolithomys*, *Yoderimys*, *Hemipsalodon*, *Hyaenodon*, *Daphoenus*, *Duchesneodus*, *Menops*, *Hyracodon*, *Amyndontopsis*, *Mesohippus*, *Trigonias*?, *Subhyracodon*?, *Toxotherium*, *Brachyhyops*, *Archaeotherium*, *Agriochœrus*, *Poabromylus*, *Eotylopus*, *Aclistomycter*, *Heteromeryx*, *Hendryomeryx*, *Leptomeryx*, and *Hypertragulus* and the last appearances of *Proterixoides*, *Sespedectes*, *Simidectes*, *Chumashius*, *Pareumys*, *Rapamys*, *Griphomys*, *Mytonomys*, *Ischyrotomus*, *Hessolestes*, *Harpagolestes*, *Duchesneodus*, *Amyndontopsis*, *Triplopus*?, *Epihippus*, *Protoreodon*, *Leptoreodon*, *Hyopsodus*, *Diplobunops*, and *Simimeryx* (Wilson, 1986; Kelly, 1990; Kelly et al., 1991; Walsh, 1991; Lucas, 1992). Additional first appearances that can now be confidently recorded in the Duchesnean are *Paradjidaumo*, *Heliscomys*, and *Simiarcitomys*. Additional last appearances recorded in the Duchesnean are “*Namatomys*” and *Simimys*.

Based on the taxa that constitute the Simi Valley Landfill Local Fauna, this fauna can be compared with other key Duchesnean North American land mammal faunas as follows: (1) it is younger than the Pearson Ranch Local Fauna from the Sespe Formation of California, the Skyline Local Fauna from the Agua Fria–Green Valley area of Texas, Lapoint Fauna from the Duchesne River Formation of Utah, and the faunal assemblages of the Badwater Locality 20 and the Wood and Rodent Localities from the Wagon Bed? Formation of Wyoming; (2) it is older than the Porvenir Local Fauna

from the Vieja–Ojinaga area of Texas; and (3) it is probably a correlative of the Lac Pelletier Lower Fauna from the Cypress Hills Formation of Saskatchewan.

Prothero et al. (1992) recently reported that the Simi Valley Landfill Local Fauna occurs within the latter part of a reversed magnetozone, which they interpret as Chron C17R. Based on K-Ar radiometric calibration, Berggren et al. (1985, 1992) regard Chron C17R to occur between about 41 and 41.5 Ma. However, revised Ar-Ar radiometric calibration presented by Prothero and Swisher (1992) places Chron C17R between about 38.7 and 39 Ma. Based on the data presented by Prothero and Swisher (1992) and Prothero et al. (1992), the age of the Simi Valley Landfill Local Fauna is about 38.7 to 38.8 Ma. Prothero and Swisher (1992) also provided revised Ar-Ar dates of 39.74 ± 0.07 Ma for the Lapoint tuff that occurs below the Lapoint Fauna between the Lapoint and Dry Gulch Creek Members of the Duchesne River Formation and 37.8 ± 0.06 Ma for the Buckshot Ignibrite of the Vieja–Ojinaga area that underlies the Porvenir Local Fauna. In addition, Prothero and Swisher (1992) questioned the validity of a K-Ar date of 42.3 ± 1.4 Ma (Black, 1969) for a biotite-bearing unit overlying the faunal assemblage from Badwater Locality 20 because it contains older detrital biotite. The age of this biotite-bearing unit has been used by other investigators as a lower age limit for the Duchesnean (e.g., Krishtalka et al., 1987; Kelly, 1990; Lucas, 1992). Furthermore, Prothero and Swisher (1992) and Prothero et al. (1992) have presented the following additional magnetostratigraphic correlations: (1) the Duchesnean Pearson Ranch Local Fauna occurs throughout most of Chron C18N, estimated between about 40.5 and 39 Ma; (2) the Duchesnean Lapoint Fauna occurs in the latter part of Chron C18N, estimated to be younger than about 39.7 Ma; (3) the latest Uintan Strathern Local Fauna, which underlies the Pearson Ranch Local Fauna, occurs in the latter part of Chron C18R, estimated to be about 40.5 Ma; and (4) the late Uintan Tapo Canyon and Brea Canyon Local Faunas occur from Chron C19N to the lower half of Chron C18R, estimated between about 42 and 40.5 Ma. The new Ar-Ar calibration of the magnetic time scale would place the Duchesnean between about 40.5 and 37 Ma (Prothero and Swisher, 1992; Prothero et al., 1992), whereas the K-Ar calibration would place the Duchesnean between about 42 and 39 Ma (Berggren et al., 1985, 1992). Lucas (1992) recently redefined the Duchesnean and regarded Duchesnean faunas as occurring from about 37 Ma to as old as 42 Ma, which he correlated with Chron C18 to part of Chron C16. Irregardless of whether the new Ar-Ar or the K-Ar calibrations of the magnetic time scale are correct, it appears that the early Duchesnean faunas occur within Chron C18N, the late Duchesnean faunas occur within Chrons C17R to C17N, and the Uintan–Duchesnean boundary occurs between Chrons C18N and C18R. All of the

above data support the biostratigraphic evidence that the Simi Valley Landfill Local Fauna is younger than the Lapoint Fauna, older than the Porvenir Local Fauna, and late Duchesnean in age.

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LITERATURE CITED

Berggren, W.A., D.V. Kent, J.J. Flynn, and J.A. Van Couvering. 1985. Cenozoic geochronology. *Bulletin of the Geological Society of America* 96:1407-1418.

Berggren, W.A., D.V. Kent, J.D. Obradovich, and C.C. Swisher III. 1992. Toward a revised Paleogene geochronology. In *Eocene-Oligocene climatic and biotic evolution*, ed. D.R. Prothero and W.A. Berggren, 29-45. Princeton, New Jersey: Princeton University Press, xiv + 568 pp.

Black, C.C. 1965. Fossil mammals from Montana, part 2. Rodents from the early Oligocene Pipestone Springs Local Fauna. *Annals of the Carnegie Museum* 38(1):1-48.

———. 1969. *Fossil vertebrates from the late Eocene and Oligocene Badwater Creek area, Wyoming, and some regional correlations*. Wyoming Geological Association Guidebook, 21st Annual Field Conference, 43-48.

———. 1971. Paleontology and geology of the Badwater Creek area, central Wyoming, part 7, rodents of the family Ischyromyidae. *Annals of the Carnegie Museum* 43(6):179-217.

———. 1978. Paleontology and geology of the Badwater Creek area, central Wyoming, part 14, the artiodactyls. *Annals of the Carnegie Museum* 47(10): 223-259.

Black, C.C., and J.F. Sutton. 1984. Paleocene and Eocene rodents of North America. *Special Publication of the Carnegie Museum* 9:67-83.

Bown, T.M. 1982. Geology, paleontology, and correlation of Eocene volcanoclastic rocks, southeast Absaroka Range, Hot Springs County, Wyoming. U.S. Geological Survey Professional Paper 1201-A:v + A1-A69, 7 pls.

Chiment, J.J. 1977. A new genus of comyid rodents (Mammalia) from the later Eocene (Uintan) of southern California. Unpublished Masters thesis, California State University, San Diego, v + 83 pp.

Cope, E.D. 1873. On *Menotherium lemurinum*, *Hypisodus minimus*, *Hypertragulus calcaratus*, *Hypertragulus tricoloratus*, *Protohippus*, and *Procamelus occidentalis*. *Proceedings of the Academy of Natural Sciences, Philadelphia* 25:410-420.

Dawson, M.R. 1966. Additional late Eocene rodents

(Mammalia) from the Uinta Basin, Utah. *Annals of the Carnegie Museum* 38(4):97-114.

———. 1968. Middle Eocene rodents (Mammalia) from northeastern Utah. *Annals of the Carnegie Museum* 39(20):327-370.

———. 1974. Paleontology and geology of the Badwater Creek area, central Wyoming, part 8, the rodent *Microparamys* (Mammalia). *Annals of the Carnegie Museum* 45(6):145-150.

Emry, R.J. 1972. A new heteromyid rodent from the early Oligocene of Natrona County, Wyoming. *Proceedings of the Biological Society of Washington* 85:179-190.

———. 1978. A new hypertragulid (Mammalia, Ruminantia) from the early Chadronian of Wyoming and Texas. *Journal of Paleontology* 52(5):1004-1014.

Farris, J.S. 1988. *Hennig86, users manual version 1.5*. Ann Arbor: Museum of Zoology, University of Michigan, 21 pp.

Gazin, C.L. 1955. A review of the upper Eocene Artiodactyla of North America. *Smithsonian Miscellaneous Collections* 128(8):1-96, pls. 1-18.

———. 1961. New sciuravid rodents from the Lower Eocene Knight Formation of western Wyoming. *Proceedings of the Biological Society of Washington* 74:193-194.

Goldman, N. 1988. Methods for discrete coding of morphological characters for numerical analysis. *Cladistics* 4(1):59-71.

Golz, D.J. 1976. Eocene Artiodactyla of southern California. *Natural History Museum of Los Angeles County Science Bulletin* 26:1-85.

Golz, D.J., and J.A. Lillegraven. 1977. Summary of known occurrences of terrestrial vertebrates from Eocene strata of southern California. *Contributions to Geology, University of Wyoming* 15:43-65.

Granger, W. 1910. Tertiary faunal horizons in the Wind River Basin, Wyoming, with descriptions of new Eocene mammals. *Bulletin of the American Museum of Natural History* 28(21):235-251.

Guthrie, D. A. 1971. The mammalian fauna of the Lost Cabin Member, Wind River Formation (Lower Eocene) of Wyoming. *Annals of the Carnegie Museum* 43(4):47-113.

Jepsen, G.L. 1937. A Paleocene rodent, *Paramys atavus*. *Proceedings of the American Philosophical Society* 78:291-301.

Kelly, T.S. 1990. Biostratigraphy of Uintan and Duchesnean land mammal assemblages from the middle member of the Sespe Formation, Simi Valley, California. *Contributions in Science* 419:1-43.

———. 1992. New Uintan and Duchesnean (middle and late Eocene) rodents from the Sespe Formation, Simi Valley, California. *Bulletin of the Southern California Academy of Science* 91(3):97-120.

Kelly, T.S., E.B. Lander, D.P. Whistler, M.A. Roeder, and R.E. Reynolds. 1991. Preliminary report on a paleontologic investigation of the lower and middle members, Sespe Formation, Simi Valley Landfill, Ventura County, California. *Paleo Bios* 13(50):1-13.

Korth, W.W. 1984. Earliest Tertiary evolution and radiation of the rodents in North America. *Bulletin of the Carnegie Museum of Natural History* 24:1-71.

Krishtalka, L., and R.K. Stucky. 1983. Paleocene and Eocene marsupials of North America. *Annals of the Carnegie Museum* 52(10):229-263.

Krishtalka, L., R.M. West, C.C. Black, M.R. Dawson, J.J. Flynn, W.D. Turnbull, R.K. Stucky, M.C. McKenna,

- T.M. Bown, D.J. Golz, and J.A. Lillegraven. 1987. Eocene (Wasatchian through Duchesnean) biochronology of North America. In *Cenozoic mammals of North America, geochronology and biostratigraphy*, ed. M.O. Woodburne, 77–117. Berkeley and Los Angeles: University of California Press, xv + 336 pp.
- Leidy, J. 1853. Remarks on a collection of fossil Mammalia from Nebraska. *Proceedings of the Academy of Natural Sciences, Philadelphia* 6:392–394.
- . 1871. Notice of some extinct rodents. *Proceedings of the Academy of Natural Science, Philadelphia* 22:230–232.
- Li, C.K., C.S. Chiu, D.F. Yan, and S.H. Hsieh. 1979. Notes on some early Eocene mammalian fossils of Hengtung, Hunan. *Vertebrata Palasiatica* 17(1):71–80.
- Li, C.K., J.J. Zheng, and S.Y. Ting. 1989. The skull of *Cocomys lingchaensis*, an early Eocene ctenodactyloid rodent of Asia. In *Papers on fossil rodents in honor of Albert Elmer Wood*, ed. C.C. Black and M.R. Dawson, Natural History Museum of Los Angeles County, Science Series 33, 193 pp.
- Lillegraven, J.A. 1976. Didelphids (Marsupialia) and *Uintasorex* (?Primates) from later Eocene sediments of San Diego County, California. *Transactions of the San Diego Society of Natural History* 18(5):85–112.
- . 1977. Small rodents (Mammalia) from Eocene deposits of San Diego County, California. *Bulletin of the American Museum of Natural History* 158(4): 221–261.
- Lillegraven, J.A., M.C. McKenna, and L. Krishtalka. 1981. Evolutionary relationships of middle Eocene and younger species of *Centetodon* (Mammalia, Insectivora, Geolabididae) with a description of the dentition of *Ankylodon* (Adapisoricidae). *University of Wyoming Publications* 45:1–115.
- Lindsay, E.H. 1968. Rodents from the Hartman Ranch Local Fauna, California. *Paleo Bios* 6:1–22.
- Loomis, F.B. 1907. Wasatch and Wind River rodents. *American Journal of Science*, series 4 23:123–130.
- Lucas, S.G., 1992. Redefinition of the Duchesnean Land Mammal "Age", late Eocene of western North America. In *Eocene–Oligocene climatic and biotic evolution*, ed. D.R. Prothero and W.A. Berggren, 88–105. New Jersey: Princeton University Press, xvi + 568 pp.
- Marsh, O.C. 1872. Preliminary description of new Tertiary mammals. *American Journal of Science and Arts* 4:122–128.
- . 1894. Description of Tertiary artiodactyls. *American Journal of Science* 48:259–274.
- Mason, M.A. 1988. Mammalian paleontology and stratigraphy of the early to middle Tertiary Sespe and Titus Canyon Formations, southern California. Unpublished Ph.D. dissertation, Department of Paleontology, University of California, Berkeley, 257 pp.
- Matthew, W.D. 1910. On the skull of *Apternodus* and the skeleton of a new artiodactyl. *Bulletin of the American Museum of Natural History* 28(5):33–42.
- . 1918. A revision of the Lower Eocene Wasatch and Wind River Faunas. Part 5. Insectivora (continued), Gilres, Edentates. *Bulletin of the American Museum of Natural History* 38:565–657.
- . 1920. A new genus of rodents from the middle Eocene. *Journal of Mammalogy* 1:168–169.
- Novacek, M.J. 1976. Insectivora and Proteutheria of the later Eocene (Uintan) of San Diego County, California. *Contributions in Science* 283:1–51.
- . 1985. The Sespedectinae, a new subfamily of Hedgehog-like insectivores. *American Museum Novitates* 2822:1–24.
- Peterson, O.A. 1919. Report upon the material discovered in the upper Eocene on the Uinta Basin by Earl Douglass in the years 1908–1909, and by O.A. Peterson in 1912. *Annals of the Carnegie Museum* 12(2–4):1–19.
- . 1931. New species from the Oligocene of the Uinta. *Annals of the Carnegie Museum* 12:40–168.
- Prothero, D.R., T.H. Dozier, and J. Howard, 1992. Magnetic stratigraphy and tectonic rotation of the middle Eocene–late Oligocene Sespe Formation, Ventura County, California. Geological Society of America, 1992 Meeting, Abstract No. 17505.
- Prothero, D.R., and C.C. Swisher III. 1992. Magnetostratigraphy and geochronology of the terrestrial Eocene–Oligocene transition in North America. In *Eocene–Oligocene climatic and biotic evolution*, ed. D.R. Prothero and W.A. Berggren, 46–68. New Jersey: Princeton University Press, xvi + 568 pp.
- Radinsky, L. 1963. Origin and early evolution of North American Tapiroidea. *Peabody Museum of Natural History, Yale University Bulletin* 17:1–106.
- Schoch, R.M. 1989. A review of the tapiroids. In *The evolution of perissodactyls*, ed. D.R. Prothero and R.M. Schoch, 298–320. *Oxford Monographs on Geology and Geophysics* 15:1–537.
- Scott, W.B., and H.F. Osborn. 1887. Preliminary report on the vertebrate fossils of the Uinta Formation, collected by Princeton Expedition of 1886. *Proceedings of the American Philosophical Society* 24: 255–264.
- Stock, C. 1932. Eocene land mammals on the Pacific Coast. *Proceedings of the National Academy of Sciences* 18(7):518–523.
- . 1934a. A second Eocene primate from California. *Proceedings of the National Academy of Sciences* 20:150–154.
- . 1934b. New Creodonta from the Sespe upper Eocene, California. *Proceedings of the National Academy of Sciences* 20:423–427.
- . 1934c. A hypertragulid from the Sespe upper Eocene. *Proceedings of the National Academy of Sciences* 20:423–427.
- . 1935a. New genus of rodent from the Sespe Eocene. *Geological Society of America Bulletin* 46: 61–68.
- . 1935b. *Pleisomiacis*, a new creodont from the Sespe upper Eocene, California. *Proceedings of the National Academy of Sciences* 21:119–122.
- . 1935c. Insectivora from the Sespe uppermost Eocene, California. *Proceedings of the National Academy of Sciences* 21:214–219.
- . 1936. Sespe Eocene didelphids. *Proceedings of the National Academy of Sciences* 22:122–124.
- Storer, J.E. 1987. Dental evolution and radiation of Eocene and early Oligocene Eomyidae (Mammalia, Rodentia) of North America, with new material from the Duchesnean of Saskatchewan. *Dakoterra* 3:108–117.
- Sutton, J.F., and C.C. Black. 1975. Paleontology of the earliest Oligocene deposits in Jackson Hole, Wyoming. Part 1. Rodents exclusive of the family Eomyidae. *Annals of the Carnegie Museum* 45(16):299–315.
- Szalay, F.S. 1976. Systematics of the Omomyidae (Tar-

siiformes Primates) taxonomy, phylogeny and adaptations. *Bulletin of the American Museum of Natural History* 156(3):157–450.

Taylor, G.E. 1983. Braided-river and flood-related deposits of the Sespe Formation, northern Simi Valley, California. In *Cenozoic geology of the Simi Valley area, southern California*, ed. R.L. Squires and M.V. Filewicz, 129–140. Pacific Section, society of Economic Paleontologists and Mineralogists, Fall Field Trip Volume and Guidebook, 266 pp.

———. 1984. Depositional environments of the Sespe Formation, northern Simi Valley, Ventura County, California. Unpublished M.S. thesis, California State University, Northridge, 168 pp.

Troxell, E.L. 1923. *Pauromys perditus*, a small rodent. *American Journal of Science* 5:155–156.

Walsh, S.L. 1987. Mammalian paleontology of the southern outcrops of the Mission Valley Formation, San Diego County, California. Unpublished senior thesis, California State University, San Diego, 171 pp.

———. 1991. Eocene mammal faunas of San Diego County. In *Eocene geologic history San Diego region*, ed. P.L. Abbott and J.A. May, 161–177. *Pacific Section, Society of Economic Paleontologists and Mineralogists Book* 68:1–227.

Wilson, J.A. 1986. Stratigraphic occurrence and correlation of early Tertiary vertebrate faunas, Trans-Pecos Texas: Agua Fria-Green Valley areas. *Journal of Vertebrate Paleontology* 6(4):350–373.

Wilson, R.W. 1935. Cricetine-like rodents from the Sespe Eocene of California. *Proceedings of the National Academy of Sciences* 21:26–32.

———. 1937. Two new Eocene rodents from the Green River basin, Wyoming. *American Journal of Science*, series 5 34:447–456.

———. 1938. Review of some rodent genera from the Bridger Eocene, part III. *American Journal of Science*, series 5 35:297–304.

———. 1940a. California paramyid rodents. *Carnegie Institute of Washington Publication* 514(5):59–83.

———. 1940b. Two new Eocene rodents from California. *Carnegie Institute of Washington Publication* 514(6):85–95.

———. 1949. Additional Eocene rodent material from southern California. *Carnegie Institute of Washington Publication* 584(1):1–25.

Wood, A.E. 1949. Small mammals from the uppermost Eocene (Duchesnean) near Badwater, Wyoming. *Journal of Paleontology* 23:556–565.

———. 1959. Rodentia. In *The geology and paleontology of the Elk Mountain and Tabernacle Butte area, Wyoming*, ed. P.O. McGrew, J. E. German, M. K. Hecht, G. G. Simpson, and A. E. Wood, 157–169. *Bulletin of the American Museum of Natural History* 117:117–176.

———. 1962. The early Tertiary rodents of the family Paramyidae. *Transactions of the American Philosophical Society* 52:1–261.

———. 1965. Small rodents from the early Lysite Member, Wind River Formation of Wyoming. *Journal of Paleontology* 39(1):124–134.

———. 1974. Early Tertiary vertebrate faunas, Vieja group, Trans-Pecos Texas: Rodentia. *Bulletin of the Texas Memorial Museum* 21:1–111.

Wortman, J.L. 1898. The extinct Camelidae of North America and some associated forms. *Bulletin of the*

American Museum of Natural History 10(7):93–142.

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APPENDIX A

CHARACTERS AND CHARACTER STATES USED IN CLADISTIC ANALYSES

1. Position of posterior margin of anterior root of the zygoma. Three states are recognized: 0, located in line between P^4 and M^1 ; 1, located in line with center of P_4 ; 2, located in line with anterior margin of P^4 .
2. Position of anterior termination of masseteric fossa. Six states are recognized: 0, located in line with the trigonid of M_3 ; 1, located in line between the posterior half to middle of M_2 ; 2, located in line with the middle of M_2 ; 3, located in line with center of anterior half of M_2 ; 4, located in line between the anterior end of M_2 to posterior root of M_1 ; 5, located in line with the middle of M_1 .
3. Number of mental foramina on mandibular ramus. Two states are recognized: 0, single foramen present; 1, two foramina present.
4. Cheek teeth crenulations. Three states are recognized: 0, not crenulated; 1, weakly to moderately crenulated; 2, extremely crenulated.
5. Size. Based on A-P length of M_2 . Four states are recognized: 0, medium 1.40–1.60 mm; 1, small 1.25–1.40 mm; 2, very small <1.25 mm; 3, large <1.60 mm.
6. P^3 . Two states are recognized: 0, present; 1, absent.
7. P^4 . Two states are recognized: 0, non-molariform with single buccal cusp (paracone) and hypocone absent or rudimentary; 1, molariform with two buccal cusps (paracone and metacone) and distinct hypocone.
8. M^{1-2} occlusal patterns in hypoconal and protoconal regions. Two states are recognized: 0, occlusal pattern not U-shaped; 1, occlusal pattern U-shaped.
9. M^{1-2} metaloph and protoloph development and occlusal shape. Two states are recognized: 0, both lophs well developed and complete forming general V-shaped occlusal pattern; 1, one or both lophs incomplete and do not form a V-shaped occlusal pattern.
10. M^{1-2} protoconule development. Three states are recognized: 0, protoconule well developed as single large conical cusp; 1, protoconule moderately reduced as elongated cusp; 2, absent or vestigial.
11. M^{1-2} metaconule development. Six states are recognized: 0, single unreduced metaconule usually present as large conical cusp; 1, single moderately reduced metaconule usually present as a relatively distinct cusp; 2, two metaconules (doubled) usually present as small reduced cusps; 3, two metaconules (doubled) usually present as well-developed cusps; 4, single very reduced metaconule usually present; 5, metaconule absent or vestigial.
12. M^{1-2} metaconule position. Two states are recognized: 0, metaconule positioned labially and in close association with metacone; 1, metaconule positioned lingually and not in close association with metacone.
13. M^{1-2} postprotocrista development. Two states are recognized: 0, absent or poorly developed; 1, moderately well to well developed.
14. M^{1-2} hypocone development. Two states are recog-

- nized: 0, moderately developed cusp; 1, well-developed cusp.
15. M^2 mesolophid. Defined as spur or loph originating near apex of protocone that extends lingually into the central basin of the tooth. Two states are recognized: 0, absent or weakly developed; 1, present as a distinct cristid or loph.
 16. P_4 size relative to lower molars. Defined as ratio of mean M_2 A-P length to mean P_4 A-P length. Four states are recognized: 0, moderately reduced (ratio = 0.75–0.90); 1, slightly reduced (ratio = 0.90–0.98); 2, very reduced (ratio = 0.65–0.75); 3, extremely reduced (ratio = <0.65).
 17. P^4 mesoconid. Three states are recognized: 0, absent; 1, present, weakly developed; 2, present, strongly developed.
 18. P_4 ectolophids. Two states are recognized: 0, absent; 1, usually developed as a complete cristid connecting the protoconid, mesoconid, and hypoconid or two almost complete cristids extending from mesoconid towards protoconid and hypoconid, respectively.
 19. P_4 hypoconid. Two states are recognized. 0, small and poorly developed; 1, well developed.
 20. P_4 posterolophid. Two states are recognized: 0, absent or very weakly developed; 1, present, well developed.
 21. P_4 protoconid. Two states are recognized: 0, usually present as a distinct cusp; 1, usually absent or vestigial.
 22. Complexity of lower molar occlusal patterns. Two states are recognized: 0, simple to moderately simple; 1, very complex with abundant small cristids and lophs present throughout the talonid.
 23. M_{1-2} trigonid size. Two states are recognized: 0, equal or subequal in size to talonids; 1, markedly narrower than talonids.
 24. M_{1-2} mesoconid shape. Two states are recognized. 0, not anteroposteriorly compressed; 1, anteroposteriorly compressed.
 25. M_{1-2} anterior cingulid development. Two states are recognized: 0, weakly developed as short low cristid; 1, well developed as long, distinct cristid.
 26. M_{1-2} anterior cingulid connection with protoconid. Four states are recognized: 0, anterior cingulid separated from protoconid by small, shallow valley and labial terminus of anterior cingulid connected to protoconid; 1, anterior cingulid separated from protoconid by distinct groove or valley and labial terminus of anterior cingulid not connected to protoconid; 2, anterior cingulid separated from protoconid by narrow groove in early wear that disappears with moderate wear to form connection between labial terminus of anterior cingulid and protoconid; 3, anterior cingulid separated from protoconid by distinct groove or valley and connected to protoconid by small but relatively persistent thin cristid originating from near labial terminus of anterior cingulid.
 27. M_{1-2} anterior cingulid connection with metaconid. Three states are recognized: 0, anterior cingulid is weakly developed as low, short cristid connected to base of metaconid; 1, anterior cingulid moderately to well-developed cristid connected to the metaconid; 2, anterior cingulid moderately developed as a distinct cristid along anterior margin of tooth and separated from metaconid by distinct gap or groove.
 28. M_{1-2} development of cusp on labial terminus of anterior cingulid. Two states are recognized: 0, not cusped; 1, cusped.
 29. M_{1-2} trigonid. Two states are recognized: 0, trigonid usually open posterolingually; 1, trigonid usually closed posterolingually.
 30. M_{1-2} protoconid. Two states are recognized: 0, protoconid not isolated, but connected or nearly connected to ectolophid and posterior arm of protoconid short or if developed usually directed towards middle of metaconid or further forward, and posterior arm is not parallel with anterior cingulid; 1, protoconid relatively isolated cusp with posterior arm of the protoconid extending to or nearly to the posterior labial base of metaconid, and posterior arm of protoconid nearly parallel with anterior cingulid.
 31. M_{1-2} hypolophid development. Two states are recognized: 0, incomplete, absent or rudimentary cristid is present that originates from the entoconid and is labially directed a short distance into the central basin of tooth; 1, complete cristid present, connecting entoconid with hypoconid resulting in a distinct enclosed valley between the hypolophid and posterolophid.
 32. M_{1-2} posterolophid development. Two states are recognized: 0, posterolophid weakly developed; 1, posterolophid well developed.
 33. M_{1-2} "mesolophids." Defined as small spurs or cristids generally directed lingually from the mesoconid into the central basin of the tooth. Two states are recognized: 0, absent or rudimentary; 1, present as one to three small spurs.
 34. M_{1-2} hypoconulid development: Four states are recognized: 0, present as well-developed isolated cusp; 1, present as moderately well-developed, often elongated, cuspule formed along posterolophid; 2, incipient hypoconulid present as a widening along posterolophid; 3, absent.
 35. M_{1-2} entoconid isolation. Four states are recognized: 0, M_{1-2} entoconid isolated and well separated from posterolophid by well-developed wide gap; 1, M_{1-2} entoconid isolated and separated from posterolophid by narrow distinct groove; 2, M_{1-2} entoconid connected to posterolophids; 3, M_1 entoconid isolated from posterolophid by narrow groove, whereas M_2 entoconid connected to posterolophid.
 36. M_{1-2} ectolophids. Defined as cristids extending from mesoconid to or near protoconid and hypoconid forming anteroposteriorly directed loph along labial aspect of tooth. Two states are recognized: 0, usually present with one or both cristids complete or nearly complete; 1, usually absent.

APPENDIX B

Character state matrix for following group of taxa: *Cocomys* (outgroup), *Reithroparamys*, *Apatosciuravus*, *Acritoparamys*, *Microparamys*, *Lophiparamys*, “*Microparamys*” *reginensis*, “*Microparamys*” *scopaiodon*, and *Pauromys*. Characters and character states are defined in Appendix A.

	Characters																									
	1	2	3	4	6	7	10	11	14	16	18	19	20	21	22	23	24	26	27	30	32	34	35	36		
<i>Cocomys</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1		
<i>Reithroparamys</i>	1	1	0	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0		
<i>Apatosciuravus</i>	2	1	1	0	0	1	2	4	1	2	1	1	1	1	0	0	0	0	1	0	0	1	0	0		
<i>Acritoparamys</i>	1	3	1	0	0	1	0	1	1	1	1	1	1	1	0	1	0	0	1	0	1	1	1	0		
<i>Microparamys</i>	2	5	0	1	1	1	1	1	1	0	1	1	1	0	0	0	0	1	1	0	1	2	1	0		
<i>Lophiparamys</i>	?	2	0	2	0	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	0		
"M." <i>reginensis</i>	?	4	0	0	?	?	?	?	?	?	?	1	1	?	0	0	1	2	1	1	1	1	1	1		
"M." <i>scopaiodon</i>	?	4	0	0	?	?	?	?	?	3	0	1	1	0	0	0	1	2	1	1	1	1	1	1		
<i>Pauromys</i>	2	5	0	0	1	1	2	5	1	3	0	1	1	0	0	0	1	1	2	1	0	2	0	1		

APPENDIX C

Character state matrix for *Cocomys* (outgroup) and reithroparamyine genera. Characters and character states are defined in Appendix A.

	Characters																									
	1	2	3	4	6	7	10	11	12	14	16	18	19	20	21	22	23	24	26	27	30	32	34	35	36	
<i>Cocomys</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	
<i>Reithroparamys</i>	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	
<i>Apatosciuravus</i>	2	1	1	0	0	1	2	4	1	1	2	1	1	1	1	0	0	0	0	1	0	0	1	0	0	
<i>Acritoparamys</i>	1	3	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	0	0	1	0	1	1	1	0	
<i>Microparamys</i>	2	5	0	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	1	1	0	1	2	1	0	
<i>Lophiparamys</i>	?	2	0	2	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	0	

APPENDIX D

Character state matrix for *Cocomys lingchaensis* (outgroup) and species of *Microparamys*. Characters and character states are defined in Appendix A.

	Characters																									
	1	2	4	5	7	8	9	11	13	15	16	17	18	19	20	21	25	26	28	29	31	32	33	34	35	
<i>Cocomys lingchaensis</i>	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>M. minutus</i>	2	5	1	0	1	0	1	1	1	0	0	2	1	1	1	0	1	1	0	0	0	1	0	2	1	
<i>M. sp., cf. M. minutus</i>	?	?	1	1	1	0	1	1	1	0	0	2	1	1	1	0	1	1	0	0	0	1	0	2	1	
<i>M. dubius</i>	?	?	1	1	1	0	1	1	0	0	0	1	1	1	1	0	1	3	1	1	1	1	0	1	1	
<i>M. sp., cf. M. tricus</i>	?	?	1	3	?	0	1	3	0	0	?	?	?	?	?	?	1	3	1	0	0	1	1	2	1	
<i>M. tricus</i>	2	5	1	3	1	0	1	3	0	0	1	1	1	1	1	1	1	3	1	0	0	1	0	2	1	
<i>M. woodi</i>	?	?	1	0	1	1	0	2	1	1	0	2	1	1	1	0	1	3	0	1	0	1	1	3	2	
<i>M. perfossus</i>	?	5	1	0	1	1	1	4	0	1	1	1	1	1	1	0	1	3	?	0	0	1	0	3	2	